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Physical Activity, Personality, Social Contexts, and Health:  
Interactions Within a Lifespan Perspective

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Margaret L. Kern

Dissertation Committee

Dr. Howard S. Friedman, Chairperson

Dr. Chandra A. Reynolds

Dr. Sonja Lyubomirsky

## ABSTRACT OF THE DISSERTATION

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Margaret L. Kern

Doctor of Philosophy, Graduate Program in Psychology  
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Dr. Howard S. Friedman, Chairperson

Through two studies, this project tested the idea that it is the convergence of individual differences and social environmental factors *across extended periods of time* that are pivotal in influencing how active a person is at any given time *and* the long-term health-related outcomes associated with different activity patterns. The first study developed archival data refined from the Terman Life Cycle study, which followed 1,528 individuals from childhood in 1922 through death. Growth curve analyses, hierarchical linear regression, and survival analyses were used to investigate patterns of physical activity across adulthood, from average age 25 to age 61, to examine individual psychosocial differences, and to determine how different trajectories relate to health, well-being, and longevity across the lifespan. There was a general pattern of decelerating decline in activity with age, but substantial individual variation that could partly be explained by child and adult psychosocial variables. Childhood energy and sociability, adult extraversion and neuroticism for males, and adult self-rated health and mental adjustment for female were strong predictors of levels and changes in physical activity. Active individuals were more likely to be healthy at midlife and old age, even after controlling for baseline health. Importantly, maintaining or increasing activity related to better health in older age, and lower mortality risk. The second study used a cross-

sectional assessment to determine personality characteristics that theoretically and empirically distinguish different activity patterns (active, sedentary, or variable), and to examine links among personality, physical activity, and health. A more active personality strongly correlated with better self-rated health and well-being, fewer perceived barriers and more perceived benefits to being active, and better social relationships. In both studies, personality impacted both physical activity levels and health, and physical activity consistently related to better health outcomes, including higher self-rated health, subjective well-being, and increased levels of energy. All together, the studies suggest that health outcomes relate to physical activity trajectories, but this may depend on the fit between the person and subsequent experiences.

## Table of Contents

|  | Page |
|--|------|
| List of tables   |      |
| List of figures  |      |
| Introduction   |      |
| Defining and measuring physical activity                                 |      |
| Physical activity benefits and trends                                    |      |
| Individual differences in activity and health outcomes                   |      |
| A lifespan perspective of physical activity antecedents and consequences |      |
| Project Aims   |      |
| Study 1  |      |
| Overview   |      |
| Method   |      |
| Participants   |      |
| Measures   |      |
| Data analytic strategy   |      |
| Growth curve modeling  |      |
| Predicting health and longevity outcomes                                 |      |
| Results  |      |
| Descriptives, correlations, and missing data comparisons                 |      |
| Growth curve modeling  |      |
| Predicting health and well-being outcomes                                |      |
| Establishing the activity predictor variables                            |      |

Cross-sectional and short-term relations  
Predicting older age health and longevity  
Supplemental analysis of activity patterns  
Joint growth-outcome analyses

Summary of findings

## Study 2

Overview

Method

Participants

Procedure overview

Measure

Variable reduction

Data analytic strategy

Cluster analysis

Defining active personality traits

Regression and SEM analyses

Cross study comparisons

Results

Activity clusters

Empirically defining active personality traits

Predicting physical activity and health

Validating the Terman activity variables

Summary of findings

## General discussion

Growth patterns and individual variation

Lifespan health and longevity outcomes

Personality, activity, and health

Cross study comparisons

Limitations

Conclusions

## References

Appendix 1: The Terman archives

Appendix 2: Terman qualitative data coding scheme, with assigned MET values.

Appendix 3: Terman Study items representing older age health (assessed in 1986).

Appendix 4: The PHAB study: Final survey

Appendix 5: The PHAB study: Items included and source of questions

Appendix 6: The PHAB study: 28 active adjectives included in the survey

Appendix 7: The PHAB study: Most often activities with MET ratings

## List of Tables

| Table |   | Page |
|-------|---|------|
| 1     | Terman sample: Basic descriptives   |      |
| 2     | Terman sample: Correlations between the five physical activity variables and other variables  |      |
| 3     | Terman sample: Missing data analysis  |      |
| 4     | Terman sample: Summary of baseline growth curve models  |      |
| 5     | Terman sample: Summary of significant between-person predictors, Males  |      |
| 6     | Terman sample: Summary of significant between-person predictors, Females  |      |
| 7     | Terman sample: Cross-sectional correlations between physical activity and health variables for the full sample and separately by sex  |      |
| 8     | Terman sample: Hierarchical linear regression analyses predicting healthy aging from physical activity variables (individual entry, controlling for age) for the full sample (controlling for sex) and by sex |      |
| 9     | Terman sample: Summary of significant relations in regression and survival analyses predicting healthy aging and longevity  |      |
| 10    | Terman sample: Joint growth-outcome analyses  |      |
| 11    | PHAB sample: Descriptives   |      |
| 12    | PHAB sample: Physical activity cluster analysis results (z score values)  |      |
| 13    | PHAB sample: Variable descriptives, by physical activity cluster  |      |
| 14    | PHAB sample: Contrast t-test comparisons of physical activity clusters  |      |

- 15 PHAB sample: Active personality descriptives and correlations with other variables
- 16 PHAB sample: Regression model results
- 17 Cross study validation: Correlations of the PHAB study individual, social, and health variables with the physical activity and active personality variables from the Terman sample
- 18 Cross-study validation: Correlations of physical activity and active personality variables and other variables measured in the Terman sample

## List of Figures

| Figure |  | Page |
|--------|--|------|
| 1      | Theoretical model  |      |
| 2      | Terman sample: Sample plots of physical activity patterns over age for two random samples of 50 males and females  |      |
| 3      | Terman sample: Expected trajectories of physical activity for eight significant predictor variables for an individual low and high on the variable, by sex |      |
| 4      | Terman sample: Mean plots of last age by group   |      |
| 5      | PHAB sample: Graphical descriptives  |      |
| 6      | PHAB sample: SEM conceptual model  |      |
| 7      | PHAB sample: Final estimated SEM model   |      |

*“If the body be feeble, the mind will not be strong. The sovereign invigorator of the body is exercise.”  
~Thomas Jefferson, 1786*

## INTRODUCTION

America has entered a fitness craze. Gym memberships, classes such as yoga, Pilates, and kickboxing, and home fitness equipment are in high demand; more people than ever are participating in endurance events such as triathlons and marathons; and people from Oprah to Obama are boasting of the benefits of exercise. As modern occupations and technology have driven sedentary lifestyles, exercise is esteemed as a royal road to health. With increasing public interest in the so-called “obesity epidemic,” the question of how people will be more active has become paramount. Yet good intentions quickly dissipate, time-crunched schedules leave little time or energy for exercise, and good intentions are repeatedly met with limited long-term success.

The human body is designed to move – joints and muscles work in unison, allowing us to do anything from crawling and walking to swimming, cycling, running, and climbing. If muscles are under-used, either through natural aging processes, illness, or inactive lifestyles, atrophy occurs and movement becomes more difficult. Physical activity relates to better physical functioning, improved mental well-being, and reduced risk of chronic illness (U.S. Department of Health & Human Services [USDHHS], 2008). Federal recommendations suggest that for the average adult, significant health benefits may accrue from engaging in at least 150 minutes of moderate-intensity activity or 75 minutes of vigorous-intensity exercise per week. Yet many individuals fail to meet even the minimal recommendations, and the question of how people will successfully initiate and maintain an active lifestyle remains challenging. The research community has studied psychosocial determinants of physical activity for the last half century, ranging

from descriptive comparisons between athletes and non-athletes to interventions aimed at increasing activity levels. A plethora of factors have been identified as potential influences on initiating and maintaining activity, but there is a need for solid, hypothesis-driven programs of research (Aidman & Schofield, 2004).

A lifespan perspective suggests that individual histories, habitual patterns of behaviors, and personality will influence subsequent behaviors (Aldwin, Spiro, & Park, 2006; Baltes, Lindenberger, & Staudinger, 2006; Crossnoe & Elder, 2002; Friedman & Kern, in press; Hampson & Friedman, 2008; Schultz & Heckhausen, 1996). This project uses a lifespan perspective to empirically assess links between personality, physical activity, and health and to examine long-term predictors and outcomes of different patterns of physical activity.

### **Defining and Measuring Physical Activity**

Although the term “physical activity” has been used to describe anything from movement that an individual performs during the day to intricately designed exercise programs, a basic definition of physical activity simply refers to body movement resulting in energy expenditure (Caspersen, Powell, & Christensen, 1985). Federal recommendations for increasing physical activity are primarily focused on physical activity done specifically for health benefits (Kahn et al., 2002). Activity has been measured in various ways, including self-report, electronic devices (e.g., pedometers, heart rate monitors), and physiological measures. There is no gold standard in measurement; all measures have strengths and weaknesses, and the choice of what to use is influenced by the focus of the study (e.g., broad patterns of activity versus

detailed studies on intensity), sample size (epidemiological studies of hundreds of people versus detailed studies on a few individuals), and cost (financial costs, participant burden, researcher resources) (Dale, Welk, & Matthews, 2002; Treuth, 2002). Activity can be characterized by type, intensity, frequency, duration, or some combination (Welk, 2002). A commonly used measure is metabolic equivalent (MET) ratings (Ainsworth et al., 2000). One MET is equivalent to the energy expended by an individual sitting quietly doing nothing, and measurement ranges from .9 METs (sleeping) to 18 METs (running at a five and half minute pace). METs are broken down into sedentary activity (less than 3 METs), moderate activity (3 to 5.9 METs), and vigorous activity (6 or more METs). This study uses self-reported leisure time activities, translated into MET values, to operationalize physical activity.

### **Physical Activity Benefits**

Physical activity has been associated with a broad array of positive health and well-being outcomes (Biddle, 2000; Blumenthal & Gulleto, 2002; DiPietro, 2001; Kujala, 2009; Pedersen & Saltin, 2006; USDHHS, 2008). Physical activity relates to better self-rated health, less disease, and improved function with chronic illnesses. Exercise has demonstrated benefits in preventing and coping with an array of chronic conditions, including insulin resistance, Type 2 diabetes, dyslipidemia, hypertension, obesity, COPD, coronary heart disease, chronic heart failure, intermittent claudication, osteoarthritis, fibromyalgia, depression, and asthma (Pedersen & Saltin, 2006). Cardiovascular system performance, muscle and bone strength, and overall fitness typically decrease with age, but evidence suggests that less decline occurs in active

individuals (Blumenthal & Gullele, 2002). Further, physical activity may be protective from mortality (Byberg et al., 2009; Lan, Chang, & Tai, 2006; Lissner, Bengtsson, Björkelund, & Wedel, 1996; Paffenbarger, Wing, & Hyde, 1978; Shaper & Wannamethee, 1991; Slattery, Jacobs, & Nichaman, 1989; Vogel et al., 2009; Wolinsky, Stump, & Clark, 1995).

Physical activity also relates to positive mental, social, and cognitive factors. Activity may impact mental health in four domains: it may help prevent depression, it may help treat depression and other mental disorders, it can increase quality of life and coping ability for those with incurable mental disorders, and it can provide a “feel good” effect for people in the general population (Biddle & Ekkekakis, 2006; Bize, Johnson, & Plotnikoff, 2007; Blumenthal et al., 1999; Lawlor & Hopker, 2001; Mutrie & Faulkner, 2004; Pedersen & Saltin, 2006). Further, living an active and socially integrated lifestyle may have cognitive benefits and may help prevent dementia and Alzheimer’s Disease (Fratiglioni, Paillard-Borg, & Winblad, 2004; Hillman, Erickson, & Kramer, 2008).

It is important to note that causal paths are not yet documented, and links remain unclear. Caution is needed due to weak study designs and inconsistent methods (Backhouse et al., 2007; Biddle & Ekkekakis, 2006; Rejeski & Mihalko, 2001; Stathopoulou et al., 2006). Physical activity has social, health, and well-being benefits, but individuals who are sociable, healthy, and happy may be more able and motivated to engage in active pursuits. Most likely, physical health, mental well-being, and physical activity affect one another in multiple ways.

### **Activity Trends**

Although a recent report indicated that more individuals engaged in regular physical activity in 2005 than in 2001 (Kruger, Kohl, & Miles, 2007), many individuals fail to meet even the minimal recommendations, and the question of how people will successfully initiate and maintain an active lifestyle remains (USDHHS, 2008). Large-scale cross-sectional analyses and smaller-scale tracking studies (using rank order correlations) suggest that physical activity levels are fairly stable through childhood and adolescence and then decline over time, with the greatest decrease occurring in the teenage years (Anderssen, Wold, & Torsheim, 2005; Boreham et al., 2004; Caspersen, Pereira, & Curran, 2000; Janz, Burns, & Levy, 2005; McMurray, Harrell, Bangdiwala, & Hu, 2003; Telama et al., 2005; Trudeau, Laurencelle, & Shepard, 2004). While using a rank order method is informative, individuals also vary significantly in the trajectories they follow through life. Furthermore, the lower cross-time correlations that typically emerge occur in the adolescent-to-adult samples include individual variation that is obscured through the statistical techniques used (Mroczek, Almeida, Spiro, & Pafford, 2006). Newer statistical techniques offer a method for directly examining individual differences, within the broader context of group-level effects.

In addition, the mechanisms explaining these links are unclear. It may be the accumulated pattern of activity over time that is most relevant to consequential outcomes, including heart disease, cancer, depression, and mortality risk (DiPietro, 2001; Paffenbarger, Hyde, Wing, & Hsieh, 1986). From a lifespan perspective, trajectories build over the life course to affect health and well-being. Adaptive and maladaptive development occurs across the lifespan within the context of individual biological and psychosocial constraints (Baltes & Smith, 2004). By studying long-term

patterns of activity, we can better understand why different individuals adopt particular behavior patterns. In turn, this understanding could lead to the design of targeted long-term experimental interventions and better-informed programs to promote positive, enduring change.

### **Individual Differences in Activity and Health Outcomes**

Baseline individual differences impact the extent to which a person leads an active lifestyle. Some degree of individual differences is biologically based. Sex is the best predictor of activity level differences, with boys and men being more active than girls and women (Sallis, 2000; Trost et al., 2002). Children differ in their activity levels (Caspi et al., 1997), and twin studies suggest that about 40% of personality-based differences in athletic ability are due to genetic influences (Klissouras, Geladas, & Koskolou, 2007). Individuals differ in their preference for different intensities of activity and in their tolerance of continued exercise when it becomes uncomfortable or painful (Ekkekakis, Hall, & Petruzzello, 2005). These baseline differences potentially impact the extent to which a person adheres to an exercise program and functions at a more active or sedentary level.

Intentions to be active, perceived behavioral control (the degree to which a person believes she controls her own actions), self-efficacy (confidence in one's ability to perform a specific behavior), goals, and motivation impact whether or not a person starts and maintains exercise behavior (e.g., Ingledew, Markland, & Sheppard, 2004; Kavussanu & Roberts, 1996; Ryan & Deci, 2000; Webb & Sheeran, 2006). Importantly, different characteristics may be important at different stages of exercise (Biddle, Fox,

Boutcher, & Faulkner, 2000; Hagger et al., 2005; Hellsten et al., 2008; Mutrie & Faulkner, 2004). For example, in a study of runners, behavioral skills and enjoyment were more important in adopting regular running, whereas social support and environmental factors were more important in maintaining regular running (Titze, Stronegger, & Owen, 2005). External motivation can help participants adopt exercise, but may hinder long-term maintenance (Dunton, 2008). Further, the match between the person and the activity may be especially important for maintaining behavior (Bailis, Fleming, & Segall, 2005; Douthitt, 1994; O'Sullivan, Zuckerman, & Kraft, 1998).

From a trait perspective, personality is consequential to health, well-being, and behavior (Ozer & Benet-Martínez, 2006; Smith, 2006). A growing body of literature suggests that personality is important in determining individual motives, intentions, preferences, and actual behavior, and should be included in models of exercise behavior (Conner & Abraham, 2001; Courneya & Hellsten, 1998). The Five-Factor Model has been the focus of much of the recent literature linking personality and health, and offers a structure for combining multiple personality traits with health and behavior (Smith & Williams, 1992). The factors are typically labeled as agreeableness (cooperative, trusting, kind, generous); conscientiousness (orderly, achievement motivated, responsible, planful); extraversion (social, active, dominant), neuroticism/emotional stability (a tendency to experience the world as distressful, proneness toward anxiety and depression, or the inverse lack of emotional problems); and intellect/openness to experience (intellectual, imaginative, creative, artistic). Conscientiousness predicts more positive health behaviors, fewer risky behaviors (Bogg & Roberts, 2004), and longer life (Kern & Friedman, 2008; Roberts et al., 2007). In a

meta-analysis of 35 studies, low neuroticism, high extraversion, and high conscientiousness were related to higher levels of physical activity (Rhodes & Smith, 2006).

Although the five main factors have been related to various important outcomes, lower-order facets may be better for specific health-related predictions. Further, traits that combine aspects of the higher order factors may be particularly informative (Brown et al., 2006; Crant, 2000; Erdogan & Bauer, 2005; Seibert, Crant, & Kraimer, 1999). For example, in a series of studies with undergraduate students, extraversion was the best predictor of exercise (Courneya, Bobick, & Schinke, 1999); however, further analyses demonstrated that it was the activity domain of extraversion that almost completely explained links between extraversion and behavior (Rhodes, Courneya, & Jones, 2002).

### **Social influences on health and behaviors**

Social norms, the physical environment, social support, and perceptions of the social environment are also relevant. The person exists within a particular social context, and this impacts both activity levels and health-relevant outcomes associated with personality and health-related behaviors. An increasing number of studies have identified social support and the perceived social environment as important correlates of physical activity (De Bourdeauhuji & Sallis, 2002; Jeffrey & Levy, 2008; Kaplan, Newsom, McFarland, & Lu, 2001; King et al., 2006; Sallis, King, Sirard, & Albright, 2007; Wolinsky et al., 1995). For example, in a qualitative study with older adults, social influences were a core reason why the elders did or did not engage in physical activity (Wilson & Spink, 2006). Norms (perceived and actual) can affect the value a person

places on being active, and this in turn can affect adherence to an exercise regimen (Nowicki, Adame, Johnson, & Cole, 1997; Okun et al., 2003). Additionally, the importance of the physical environment is increasingly being acknowledged (DiPietro, 2001; Kahn et al., 2002; Kavussanu & Roberts, 1996, Sallis et al., 2007; Trost et al., 2002).

### **A Lifespan Perspective of Physical Activity Antecedents and Consequences**

Although studies have focused on various individual and social predictors of activity levels, from a lifespan perspective, it is important to examine a broader picture of activity *patterns*, and consider not only who will be active across several months, but also across extended periods of time. It may be the accumulated pattern of activity over time that is most relevant to consequential outcomes, including heart disease, cancer, depression, and mortality risk. Little is known about long-term physical activity trajectories and lifespan health outcomes (DiPietro, 2001; Li et al., 2005, MacKinnon & Luecken, 2008).

The main thesis of this project is that it is the convergence of individual differences and social environmental factors *across extended periods of time* that are pivotal in influencing both how active a person is at any given time *and* the long-term health-related outcomes associated with different activity patterns. [Figure 1](#) presents a theoretical model that relates an active lifestyle to health outcomes, but this relation depends on personality factors (such as biological dispositions toward activity and internal drive), social factors (e.g., social norms and support, environment, stress), and the interaction of the two.

In this model, there is a basic individual difference in preference for activity<sup>1</sup> that can be characterized by a set of traits. These differences arise from multiple inter-related early factors: genetic propensities, temperament, personality (e.g., energy, stamina, motivation, self-directedness), parental attitudes and behaviors, body type, and prior experiences with exercise. Individuals with a high inclination for activity will be drawn toward an active lifestyle and are more likely to obtain superior health and well-being outcomes. However, setbacks and barriers can arise (e.g., prolonged injury, stress imposed by the environment or others, changes in priorities due to life events), leading toward inactivity, poor health, and ill-being, as such inactivity works against their natural inclination toward activity. In contrast, individuals with a low inclination for activity will often live an inactive lifestyle, and other factors, such as diet, social relationships, stress, and other health behaviors and psychosocial factors will be more relevant to health, as well as to maintenance of exercise. (A dichotomy is used for conceptual simplicity, but it is assumed that there is a continuum of propensities.)

The model proposes that personality-based differences drive different trajectories toward health and well-being or disease and ill-being. However, this is moderated by social factors and stressful experiences. An active lifestyle functions as a marker of a healthy trajectory. The most resilient individuals potentially are active individuals who successfully utilize social relationships to support a healthy lifestyle. Activity levels depend on the individual's history, predispositions, and psychosocial environment, and trajectories of past physical activity will inform current activities. Altogether, this model

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<sup>1</sup> This is displayed as a preference toward being physically active. However, in some cases, such as when physical limitations prevent active pastimes, it will be displayed as a preference toward being mentally active.

suggests that health outcomes (physical and mental) do stem in part from physical activity, but this depends on the fit between the person and subsequent experiences.

## **Project Aims**

This project aimed to examine this theoretical model through two separate but related studies. The first study used archival data refined from the Terman Life Cycle study to examine long-term predictors and outcomes of different physical activity patterns. The second study used a cross-sectional assessment to empirically determine what personality characteristics distinguish different activity patterns (active, sedentary, or variable), and to examine links between personality, physical activity, and health.

### **Study 1:**

#### **Lifespan Physical Activity Patterns in the Terman Life Cycle Study**

The first study used archival data derived, refined, and developed from the Terman Life Cycle Study to investigate patterns of physical activity within the context of individual psychosocial differences, and to determine how different trajectories relate to health, well-being, and longevity across the lifespan.

Archival studies offer a way to study processes over time. By creatively developing existing resources, we can address lifespan questions that are impossible in shorter-term studies (Block, 1993). Archival studies have limitations: the initial investigators usually were interested in different questions, measures may be outdated or nonexistent, missing data and attrition can be problematic, and archives often

constitute select groups that may not generalize to other population groups (Elder, Pavalko, & Clipp, 1993; Martin & Friedman, 2000; Tomlinson-Keasey, 1993). Yet to truly understand lifelong processes, collecting appropriate data would involve a lifelong commitment, extending well beyond the lifetime and resources (both in terms of time and funding) of a single individual (Block, 1993). Further, existing studies offer a wealth of data that represent huge investments by prior researchers. By building on prior work, we can augment the field and science as a whole.

Archival work is a long process, involving developing an extensive knowledge of the data, carefully considering validity issues, and the possibility of recasting parts of the archive to address different questions. *Recasting* refers to a process of restructuring existing data to create new measures of a construct (Elder et al., 1993). It is not simply recoding; it entails taking a new theoretical model and attempting to shape the data to answer specific research questions. Deciding to recast an archive is a big decision; the strengths and weaknesses of the data need to be considered, and the process needs to be driven by theory and specific research questions.

I have spent the past four years working to recast qualitative information from the Terman Life Cycle Study to examine patterns of leisure time physical activity across four decades. The study was begun in 1921-22 by Lewis M. Terman, as a descriptive study of gifted children (Terman et al., 1925). Recruitment efforts continued through 1928, eventually including over 1,500 individuals. A follow-up attempt was begun in 1936, and about two-thirds of the original sample was contacted (Sears, 1984). Efforts continued, and the majority of the sample was brought back into the study by 1940. Participants were followed prospectively throughout their lives, completing written assessments

every five to ten years. In addition, our research team has supplemented this information by collecting death certificates, presenting a full lifespan picture of most of the participants. Thus, the Terman study is the longest longitudinal study with repeated measurement that has been conducted, and the archived information is an immense resource that offers a unique lifespan portrait of these individuals' lives. Our work in developing the Terman data has demonstrated that we can learn much about lifelong pathways by refining available information and tracing lives over time (Kern & Friedman, in press). Although not all participants completed every measure, we can use the extant information to understand the sample as a whole and to explore individual variation within the sample.

In an initial study, we explored whether there was any measurable stability of activity from childhood through old age (Friedman et al., 2008). In 1922, parents and teachers rated how active and energetic the children were, and the child participants (and their parents) indicated how much the participants enjoyed physically active pastimes. From 1936 through 1972, participants reported the various activities they engaged in, and we coded these into three activity levels (low, moderate, or vigorous). Interestingly, childhood energy was significantly related to active hobby reports across the lifespan, suggesting that an individual's early characteristics are relevant to future physical activity levels. Although encouraging, that study used a very rough measure of physical activity, simple cross-time correlations, and did not consider the role of personality.

The present study capitalized on the more in-depth qualitative resources available in the archives to study long-term activity *patterns* by using an in-depth

assessment of leisure time activities, growth curve modeling techniques to consider individual variation, examination of childhood and adult personality predictors of different trajectories, health and longevity outcomes, and sex-related differences. There were five specific objectives:

- 1) to recast the Terman data to examine activity patterns over time, through a quantitative analysis of qualitative data provided by the participants across a 36-year period;
- 2) to determine an average pattern of physical activity level and change for the sample;
- 3) to explore personality predictors of individual variation;
- 4) to examine sex-related differences in activity patterns and variation; and
- 5) to examine health, well-being, and longevity as outcomes of activity trajectories.

## **Study 1 Method**

### **Participants**

In 1921-22, teachers across California were asked to identify the youngest and most intelligent students in their classes (Terman et al., 1925). The children were tested using the Stanford-Binet Intelligence test and were included in the study if they had an IQ of 135 or greater. Others were added through 1928, yielding a total sample of 1,528 participants (856 males, 672 females). Participants were then followed throughout their lives, completing written and supplemental assessments every five to ten years. In 1936, 1940, 1950, 1960, and 1972, participants reported their leisure time physical activities (see below); 536 individuals (284 M, 252 F) completed all five occasions, 376

(212 M, 164 F) completed four occasions, 228 (146 M, 82 F) completed three occasions, 158 (92 M, 66 F) completed two occasions, and 111 (64 M, 47 F) completed one occasion. Rather than exclude individuals with partial information, maximum likelihood estimation allows inclusion of all available data; the number of waves can vary by individual, as long as each individual contributes at least one measurement occasion and enough participants contribute a sufficient number of reports to adequately estimate a growth process (McArdle, 2004; Singer & Willett, 2003). Individuals were excluded if they did not have at least one activity score ( $N = 119$ ), leaving a final sample of 1,409 participants (798 M, 611 F).

The 119 individuals excluded from the study (with no physical activity reports between 1936 and 1972) were compared to the 1,409 individuals with at least one activity report. Not surprisingly, the largest difference was that those excluded died at an earlier age (46.0 years versus 75.7 years), including 42 individuals who died prior to the first major 1936 follow-up assessment and therefore had no opportunity to complete the activity measures. Those excluded came from a lower socioeconomic status ( $t(1205) = -2.28, r = -0.12, p = .02$ ). For individuals who remained alive through the 1936 assessment (but did not report activity information), excluded individuals completed fewer years of education ( $t(1369) = -3.37, r = -0.43, p = .0008$ ), reported lower levels of adult conscientiousness ( $t(1231) = -2.95, r = -0.32, p = .003$ ), and were rated as less mentally adjusted in adulthood ( $t(1363) = -5.01, r = -0.43, p < .0001$ ). The two groups did not differ significantly on any other variable tested (including IQ, sex, baseline health in 1922, childhood activity, birth weight, age of puberty, child and adult personality, self-rated health, body mass index, and alcohol use).

Despite the many strengths of the Terman Life Cycle Study, including limited attrition and the range of variability on non-IQ relevant traits, there is reasonable concern about the potential lack of generalizability of effect sizes to the larger U.S. population. The impact of selection due to intelligence and education was examined (Reynolds, McArdle, Kern, & Friedman, 2007). The Pearson-Aitken-Lawley correction procedure was used to examine the impact of selection due to intelligence and education (Aitken, 1934; Lawley, 1943-44; Pearson, 1902). This procedure uses knowledge of actual population means, variances, and covariances among selection traits. For intelligence, a mean of 100 and standard deviation of 15 was used. For education, sample statistics from the General Social Surveys for the same birth cohort as the Terman sample was used (Davis, Smith, & Marsden, 2007). While cognitive traits showed a large effect, health-related variables, including physical activity, showed minimal effects. Specifically, for males, average physical activity levels were slightly lower than expected for the general population (mean effect size difference [ $M_{Esd}$ ] = -0.18), whereas for females, average physical activity levels were slightly higher ( $M_{Esd}$  = 0.19). Covariances and variances demonstrated minimal differences. These analyses imply that in these data, longitudinal analyses of covariance structures can proceed without adjustment for selection. Although the Terman cohort, like any archival cohort study, necessarily has certain limits on generality, studies with the data have confirmed that it is well suited for a study of lifelong activity. Further, it may be the only such comprehensive lifelong data available.

## **Measures**

### Physical Activity: Recasting the Data

The original data for the Terman study are housed at Stanford University. Many of the main questionnaires were coded and archived as computerized datafiles by others (Sears, 1984), however, substantial uncoded and more precise information remains available in the original surveys (see [Appendix 1](#) for a visual survey of the archives).

In 1936, 1940, 1950, 1960, and 1972, participants were asked to report “Avocational activities and hobbies in recent years (such as sports, music, art, writing, aviation, photography, collections, gardening, wood work, etc.)” in free-response format. After considering the amount of qualitative information available in the archives and the specific research questions, it was decided to collect the additional data, recast the data to address more in-depth research questions, and to expand analyses to all available mentions written on the original hard copies of the questionnaires.<sup>2</sup>

Through multiple trips to Stanford University, all participant responses to the activity questions were recorded as written. A coding scheme was created to classify the qualitative responses. Responses were compiled into 182 categories (see [Appendix 2](#)). Three trained undergraduates students coded all responses into these categories, and all responses were checked for agreement and accuracy. Three trained graduate students then rated each of the 182 activity categories on the MET scale (average inter-rater reliability  $r = 0.91$ ; complete agreement across items was then achieved through discussion). Low intensity activities (less than 3.0 METs) included cooking, music, playing cards, reading, socializing, and typing. Moderate intensity activities (3.0 to 5.9

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<sup>2</sup> Participants listed up to 17 activities; the original codes ignored additional responses. In addition, activities were coded very broad. For example, all sports were grouped into one category. When considering activity intensity, there are large differences between sports such as golf, bowling, volleyball, tennis, running, and cross-country skiing.

METs) included boating, carpentry, gardening, and golf. Vigorous intensity activities (6.0 or more METs) included backpacking, biking, handball, running, skiing, and tennis (see [Appendix 2](#) for the MET ratings that were assigned to each category). Finally, the average MET values reported for each year were computed; these averages were used as the main variables in subsequent analyses.

### Psychosocial Predictor and Control Variables and Midlife Mechanisms

The main predictors were measures of child and adult personality.<sup>3</sup> In addition, to control for some psychosocial aspects, indicators of childhood intelligence (IQ), socioeconomic status (SES), physical development, and physical and mental health were included. Potential midlife mechanisms included physical and mental health, social ties, hardship, and education. Sex is typically the strongest predictor of leisure time activity; therefore, analyses considered sex-related differences. Missing data reduced the number included in some analyses, as noted below.

*Childhood personality.* In the initial 1922 assessment, parents and teachers rated the children on 25 different personality traits. Through factor analysis, six personality dimensions have previously been identified (Friedman et al., 1993): cheerfulness ( $\alpha = 0.52$ ), conscientiousness ( $\alpha = 0.76$ ), energy ( $\alpha = 0.43$ ), motivation/self esteem ( $\alpha = 0.71$ ), sociability ( $\alpha = 0.65$ ), and permanency of moods (single item). Childhood personality information was available for 1,325 participants (750 M, 575 F). Prior studies with this sample found that high energy predicted higher levels of activity (Friedman et al., 2008), and conscientiousness predicted longer life and better health across the lifespan (Friedman et al., 1993). It was expected that these two traits would predict

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<sup>3</sup> For personality, following existing literature, predictions were made for activity levels, but not for change, as this has not been previously studied.

higher levels of activity and better health. Further, the sociability variable is similar to extraversion and was expected to predict higher levels of activity in adulthood.

*Adult personality.* In 1940, participants completed the Bernreuter Personality Inventory (Bernreuter, 1933) and 14 other self-rated personality traits. From these, scales corresponding with four of the NEO PI-R dimensions were created and validated (Martin & Friedman, 2000): agreeableness ( $\alpha = 0.72$ ), conscientiousness ( $\alpha = 0.65$ ), neuroticism ( $\alpha = 0.85$ ), and extraversion ( $\alpha = 0.65$ ). Adult personality information was available for 1,214 participants (683 M, 531 F). It was expected that higher levels of extraversion and conscientiousness and lower levels of neuroticism would predict higher levels of activity.

*Childhood IQ.* IQ was included as a control, but was not expected to relate to physical activity levels or change (Reynolds et al., 2007). At the 1922 baseline assessment, all participants completed the Stanford-Binet Intelligence test and several additional tests; Terman and his colleagues determined an overall best-estimated childhood IQ level. IQ data were available for all 1,409 participants.

*Childhood SES.* In 1922, parents reported their own highest grade level completed, additional schooling experiences, and current occupation. Occupation was coded according to the census categories of the time, ranging from unskilled to professional levels. As many women did not work outside the home, if the mother was a homemaker, the father's occupation was used to represent the mother's occupation. The parental education and occupation levels were standardized and summed to create a composite SES score ( $\alpha = 0.86$ ). SES data were available for 1,114 participants (557 M, 557 F).

*Birth weight, infant health, and pubertal age.* Children develop physically at different rates, and this may be relevant to how active they become. Birth weight, infant health, and pubertal age were included as markers of early physical development. In 1922, parents reported the child's birth weight. Although these were retrospective reports, weight is often recorded at time of birth (e.g., baby diaries) and is likely reasonably objective. Parents also freely reported the child's health during the first year. Based on these reports, Terman and his colleagues compiled this information into a 5-point scale. As most participants were in good or very good health, the item was rescaled to a 4-point scale (1 = poor/very poor health, 4 = very good). In 1922 and 1928, parents reported the age of menstruation (for females) or voice change (for males); these were used as markers of pubertal age. Data were available for 1,215 participants (685 M, 530 F) for birth weight, 1,229 participants (688 M, 541 F) for infant health, and 1,040 participants (492 males, 548 females) for puberty.

*Childhood activity.* In 1922, parents freely responded to the question "how has child spent leisure time during the last 2 years (examples: games, hiking, playing alone, reading, study, hobbies, etc.)?" The first three mentions were coded into rough categories. Three trained judges rated the level of activity required for the pastime on a 6-point scale (0 = no activity, 1 = highly inactive, 6 = highly active; average inter-rater reliability:  $r = 0.85$ ). Scores were summed to create a total 1922 parent-rated activity score. In addition, child participants indicated on a 5-point scale (1 = dislike it very much, 5 = like it very much) how much they enjoyed "playing games that require lots of energy". This was used as an indicator of childhood preference for being active. Data

were available for 1,243 participants (707 M, 536 F) for parent-rated activity and 1,310 participants (737 M, 573 F) for child preference for active pastimes.

*Body mass index.* In 1940, adult participants self-reported their height and weight. Body mass index (BMI) was calculated using the Quetelet's formula ( $BMI = \text{kg}/\text{m}^2$ ). Obesity was uncommon in this sample. BMI data were available for 1,220 participants (679 M, 541 F). Mean and median BMI were 22.75 (mean,  $SD = 2.50$ ) and 22.71 (median) for males, and 21.15 (mean,  $SD = 2.74$ ) and 20.66 (median) for females.

*Adult health and adjustment.* Most likely, physical health, mental well-being, and physical activity affect one another at multiple levels; therefore, health and well-being were used as both predictors and outcomes of activity trajectories. Beginning in 1936, participants self-reported their overall health in recent years on a 5-point scale. As most participants reported good or very good health, responses were scaled on a 4-point scale (1 = poor or very poor, 4 = very good). Participants reported whether they had experienced any nervousness, worry, or other difficulties in recent years, and the nature of these difficulties. In 1940, 1950, and 1960, Terman and his colleagues used a combination of these reports, case histories, and knowledge from personal correspondence to classify each participant's mental adjustment (1 = serious maladjustment, 2 = some maladjustment, 3 = well-adjusted). In addition, participants reported their normal alcohol use. Alcohol abuse may serve as a proxy for mental maladjustment. Based on the 1940, 1950, and 1960 reports, participants were categorized on a 3-point Likert scale (1 = no or minimal alcohol use, 2 = moderate

alcohol use, 3 = high alcohol use or alcohol is a serious problem<sup>4</sup>). From these reports, two sets of variables were created: (a) 1940 reports were used as early adult predictors of activity patterns; and (b) reports from 1950 and 1960 were averaged<sup>5</sup> and tested as potential mechanisms linking activity patterns to later life outcomes. In 1940, data were available for 1,230 participants (686 M, 544 F) for physical health; 1,337 participants (752 M, 585 F) for mental adjustment; and 1,227 participants (685 M, 542 F) for alcohol use. At midlife, data were available for 1,303 participants (735 M, 568 F) for physical health; and 1,302 participants (734 M, 568 F) for mental adjustment and alcohol use.

*Social ties.* At the 1940, 1950, and 1960 assessments, participants reported information on social ties (marital status, number of living children and siblings, number of service activities and organization memberships). For marital status, participants reported their marital status and changes in status since the last assessment. Participants received a 1 if they were married at the assessment and a 0 if they were not married (regardless of the reason). Participants reported how many living children and siblings that they had. Participants freely reported their involvement in service activities and organizations and the number of activities or organizations listed was recorded. These variables were summed to create a measure of social ties (0 = none, 13 = 13 or more). It was expected that social ties would positively relate to more physical activity and better health. From these variables, 1940 reports were used as an early adult predictor, and the average of 1950 and 1960 was used as a potential

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<sup>4</sup> In some cases, participants did not report alcohol problems, but case histories indicated problems, so participants were categorized accordingly (by Terman and his colleagues).

<sup>5</sup> If participants reported both 1950 and 1960 data, then reports were averaged ( $\alpha = 0.62, 0.89, \text{ and } 0.74$ , for health, adjustment, and alcohol respectively). If only one year was reported, then the reported value was used.

mechanism linking activity to later life. Social ties information was available for 1,283 participants (714 M, 569 F) in 1940 and 1,303 participants (735 M, 568 F) at midlife.

*Midlife hardship.* In 1950, participants reported on various hardships including death of close family members and hardships experienced by self, spouse, parents, siblings, and offspring. Participants received a 1 for each event reported, and a summed score was created ranging from 0 (no hardships reported) to 3 (3 or more hardships reported). Data were available for 1,266 participants (714 M, 552 F).

*Educational attainment.* At each assessment, participants indicated the highest level of education completed and any additional schooling accomplished during each interlude. Based on these responses, a total educational attainment score was constructed, ranging from 10 years (i.e., two years of high school or equivalent) to 22 years (i.e., obtained Ph.D. and completed additional coursework). Education information was available for 1,358 participants (768 M, 590 F).

### Late Life Health Outcome

*Healthy aging.* In the 1986 assessment (when participants were about 75 years old), many of the questions addressed later life experiences, including health and well-being. Combining theory-based rational assessment (ratings by trained graduate students) and empirical analyses (correlations, inter-rater reliability, and factor analysis), four facets of health were identified, representing different aspects of health: physical health (10 items, Cronbachs  $\alpha = 0.75$ ); subjective well-being (10 items,  $\alpha = 0.71$ ); social competence (8 items,  $\alpha = 0.71$ ); and productivity (10 items,  $\alpha = 0.72$ ). Items were standardized and summed to create a multifaceted measure of late-life healthy aging (Friedman, Kern, & Reynolds, 2010). [Appendix 3](#) lists the items included on each scale.

*Mortality.* We have collected death certificates for most of the participants (89.2%) through 2008 to verify date and cause of death. Collecting the certificates entails searching online records for potential deaths, matching names, date of birth, and potential place of death (we do not have social security numbers for the participants, so this is a challenging task). When a potential match is found, we write to the state or county office and request a certificate be sent. This can be relatively simple (in states such as California, where an “information only” copy is accessible to anyone), or nearly impossible (some states require an intensive review process, and others still have not given permission for the release of this information). Once the certificate is received, we compare the information with the other information we have (place of birth, parental place of birth, occupation, etc.) and determine if the certificate matches the participant. If we cannot make a positive identification based on the information that we have, we take the certificate to Stanford to compare against additional notes in the archives. If question stills remains, the death certificate is rejected as a match. Death information was available for 1,258 participants (736 M, 521 F). For the remaining 159 individuals potentially still alive, the average age (as of 2008) was 94 years old.

## **Data Analysis**

### Analytic Strategy Overview

Developmental questions can best be addressed using multiple methods (Little, Bovaird, & Slegers, 2006). Descriptives, graphs, and correlations were used as a baseline exploration of the data. A missing data analysis was performed in MPlus, which uses a maximum likelihood estimate (MLE) process to estimate what the

expected means, standard deviations, and correlations would be if all participants reported activity scores at all five time points (McArdle, 2004). Multilevel modeling techniques were used to model physical activity level and change over time and to examine personality predictors of inter-individual differences. Hierarchical regression and survival analyses predicted aging and death outcomes from levels and patterns of physical activity. In addition, joint models simultaneously estimated growth and late life outcomes. Analyses were performed primarily using SAS (version 9.2) software, with missing and joint analyses performed using MPlus (version 4.2; Múthen & Múthen, 2007) software. As sex differences are generally found in physical activity research, analyses were performed with the whole sample and separately by sex.

### Growth Curve Modeling

In the multilevel modeling framework, individual growth trajectories are estimated, producing fixed and random effects (Singer & Willet, 2003). Fixed effects characterize the overall average trajectory for the sample, whereas random effects characterize individual variation around this trajectory. First, as an initial survey of the data, individual activity reports were plotted for sets of randomly selected participants (see [Figure 2](#) for sample plots of 50 randomly selected males and 50 randomly selected females). The plots suggested a gradual downward trend, but there was a surprising degree of individual variation; this variation is what the main analyses attempted to observe and explain. Second, using the full data, a taxonomy of models was fit to the data in a step-up fashion to determine the best base model by fitting an unconditional means (no growth) model, in which the best fitting average trajectory is constant (i.e., not increasing or decreasing); an unconditional linear growth model, in which the best

fitting average trajectory increases or decreases linearly over time; and an unconditional quadratic model, in which the best fitting average trajectory follows a nonlinear pattern. Third, predictor and control variables were added to the model, individually and multivariately.

Based on prior cross-sectional research (e.g., Caspersen et al., 2000), it was expected that as people aged, they would display a decelerating decline in activity (i.e., a quadratic model). The following equation represents the basic quadratic growth model with one predictor included:

$$Y_{ij} = \gamma_{00} + (\gamma_{01} * W_i) + (\gamma_{10} * age_{ij}) + (\gamma_{11} * W_i * age_{ij}) + (\gamma_{20} * age_{ij}^2) + (\gamma_{21} * W_i * age_{ij}^2) + [\zeta_{0i} + (\zeta_{1i} * age_{ij}) + (\zeta_{2i} * age_{ij}^2) + \varepsilon_{ij}] \quad (1)$$

where  $W_i$  refers to individual  $i$ 's value on the predictor (e.g., extraversion), centered on the sample mean;  $age_{ij}$  refers to the  $i$ th individual's age at each  $j$ th measurement occasion centered on the average age in 1940 (29 years);  $age_{ij}^2$  refers to the centered age squared;  $\gamma_{00}$  refers to the average MET value at age 29 at the mean level of the predictor;  $\gamma_{10}$  refers to the instantaneous linear change in MET values at age 29;  $\gamma_{20}$  refers to the quadratic shift or curvature of the MET trajectory across age;  $\gamma_{01}$  refers to the shift in the intercept due to predictor  $W$ ;  $\gamma_{11}$  refers to the shift in the linear effect due to predictor  $W$ ;  $\gamma_{21}$  refers to the shift in the quadratic parameter due to predictor  $W$ ;  $\zeta_{0i}$ ,  $\zeta_{1i}$ , and  $\zeta_{2i}$  are the individual deviations from the fixed intercept, linear, and quadratic terms; and  $\varepsilon_{ij}$  is the occasion-specific residual term. The variances of these deviations are the random effects, and represent individual variation in growth trajectories.

The main individual predictors included childhood personality (cheerfulness, conscientiousness, energy, motivation, sociability, permanency of moods) and adult

personality (extraversion, neuroticism, conscientiousness, agreeableness). Personality variables were entered individually and then simultaneously, such that the individual effect of each predictor on activity patterns is evident, controlling for the effects of the other predictors in the model (i.e., the other childhood or adult personality variables). Control variables (childhood IQ, SES, health, parent-rated activity, child interest in active pastimes, birth weight, and age of puberty; and adult BMI, self-rated health, mental adjustment, alcohol use, and social relationships) were tested individually, and then significant variables were included in the personality models.

When adding variables to the model, missing data changes the number of data points included in the model. Therefore, as predictors were added to the model, a new baseline model was fit each time that only included the participants with non-missing data on the included predictors, such that the fit indices were comparable with the baseline model.<sup>6</sup> To aid interpretation, age was centered on the average age in 1940 (29 years old), and all predictor variables were centered on their respective grand means. Thus, in the context of the quadratic change model, the fixed level (intercept) effect refers to the average MET value at age 29, and the fixed linear (slope) effect indicates the linear rate of change in activity at age 29. The quadratic parameter reflects the curvature in the trajectory of MET values across age.

Model fit was assessed primarily through comparison of deviance statistics, with each nested model being compared to the prior model. Differences in deviances can be assessed via the chi square distribution, with degrees of freedom equal to the change in

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<sup>6</sup> Although programs such as MPlus allow missing data on the growth variables, missing data is not allowed on other variables. Rather than doing some sort of imputation, it was decided to only use participants with complete data for the variables of interest.

*df* between models. A significant chi square denotes that the model fits better than the previous model and should be retained. However, chi square can be susceptible to sample size; therefore, the parsimony-adjusted fit indices AIC (Akaike's Information Criteria) and BIC (Bayesian Information Criteria), where smaller values indicate a better fit, were also considered. In addition, pseudo  $R^2$ s for the linear and predictor models were calculated, as rough indicators of the importance of including additional variables in the model (Singer & Willet, 2003). The pseudo  $R^2$  for the linear model indicates how much within-person variance is explained by including time in the model. The pseudo  $R^2$  for the predictor models indicate how much between-person variance is explained by including the variable in the model.

#### Predicting Health and Longevity Outcomes: Regression and Survival Analyses

An important question is whether activity levels and patterns relate to older age health and longevity. It is often assumed the activity is beneficial, but most findings are based on cross-sectional or short-term studies. To consider lifespan relations, activity levels and patterns were used to predict midlife health and well-being (1950 and 1960 reports), older age health and well-being (1986, when participants were in their 70s), and longevity (through 2008).

*Establishing physical activity predictors.* Several variables were examined as predictors of health and longevity. First, the average activity level (i.e., the average MET values described above) for each year was used as independent predictors. Second, the number of activities reported each year (regardless of the activity level) was used as predictors. Third, using the growth analyses described above, the empirical Bayes estimates of the intercept and slope were saved for each individual, and these values

were used as independent predictors. Due to the correlated nature of these different variables, each was considered independently. The empirical Bayes estimates offer a two-stage approach to growth and survival (McArdle, Small, Backman, & Fratiglioni, 2005). The resulting value indicates the risk associated with level of activity at the centering point (in this case, average activity in 1940), and the risk associated with change in activity. Finally, a joint growth-survival model was estimated, which simultaneously estimates the growth parameters and regression parameters (McArdle et al., 2005).

*Cross-sectional and short-term health outcomes.* Correlations between 1936 and 1940 health, adjustment, and physical activity were examined. Hierarchical linear regression was then used to predict health and mental adjustment in 1940 from the 1936 and 1940 activity reports. Similarly, 1950 and 1960 activity were correlated with and used to predict midlife health and adjustment. Age and sex (in the full sample) were controlled in the regression analyses.

*Healthy aging.* Regression was used to predict 1986 physical health, subjective well-being, social competence, and productivity, controlling for age and sex. For significant relations, midlife variables (health, well-being, alcohol, hardships, education, and social ties) were added to test for potential mediating effects.

*Survival (Longevity).* Cox proportional hazards regression analyses were used to estimate mortality risk from the activity variables, controlling for age and sex. Survival analyses estimate the risk of dying at a given age, compared to others in the sample. The major advantage of survival analysis is that data can be censored and time-dependent covariates can be included (Allison, 1995; Singer & Willet, 2003). In the

Terman data, cases may be censored because they are still alive (right censoring) or because they dropped out of the study (i.e., they could be alive or dead, but we use information from the last age that we heard from them). Cox regression involves proportional hazard modeling, estimated through a maximum partial likelihood method. The basic Cox model, written in terms of a log cumulative hazard, is defined as:

$$\log h(t_{ij}) = \log H_0(t_j) + \beta_1 X_{1ij} ,$$

where  $\log H_0(t_j)$  refers to the general baseline function,  $\beta$  is the constant shift, and  $X$  is the predictor value for the individual ( $i$ ). This model makes no assumptions about the underlying function, but does assume that the function is constant across age; this assumption can be relaxed by including a time-varying component (i.e., the Gompertz model; Allison, 1995).

### Joint Growth-Outcome Analyses

Using MPlus, joint analyses estimated growth parameters and late life outcomes (healthy aging and all-cause mortality) in the full sample. Joint analysis is a relatively new technique that simultaneously estimates both the growth and regression parameters. The benefit of simultaneous entry is that the maximum likelihood estimates that define the random growth parameters are conditioned not only on the average and individual variation, but also on outcome information (McArdle et al., 2005). The standard errors of key parameters tend to be smaller, increasing confidence in the estimates. As a relatively recent data analytic strategy, there remain some issues with model evaluation that are still under debate, and model runs can be lengthy, so a limited number of models were examined.<sup>7</sup>

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<sup>7</sup> Models took anywhere from 30 seconds to 90 minutes to run. As computer programs continually are being improved, confidence in these modeling techniques is being established, and computers can

## Study 1 Results

### Descriptives, Correlations, and Missing Data Comparisons

Descriptive statistics for all predictor, control, and outcome variables are summarized in [Table 1](#), and correlations between the physical activity variables and psychosocial and behavioral variables are summarized in [Table 2](#). Physical activity is reported in average MET values. On average, the sample was 25 years old ( $SD = 3.65$  years) at the first activity assessment (1936) and 61 years old at the last activity assessment (1972), and participants reported a moderate to low level of activity (ranging from 3.29 METs in 1940 to 2.53 METs in 1972).

[Table 3](#) summarizes missing data patterns for the physical activity variables, with patterns of missingness, percentage of covariance coverage, and the expected means, standard deviations, and correlations, for the full sample and separately by sex. Overall, there were 31 different missing patterns, although most individuals followed several similar patterns. Comparing the correlations from complete cases (values above the diagonal in the activity section of [Table 2](#) with [Table 3](#) part d), there were minimal changes in correlation and mean values, suggesting that the data meet the minimal conditions of “missing at random”.

It is also possible that differential attrition occurred, such that individuals who completed the later assessments differed in some way from those who completed fewer assessments or dropped out of the study. To test this, individuals who completed four or five assessments were compared to those who completed three or fewer. Those with

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handle the computational complexities more efficiently. The results presented here offer a preliminary attempt at using and understanding these modeling techniques; future analyses will explore this option in more detail.

more physical activity reports were more conscientious as children ( $t(1323) = 2.83, p = .005$ ) and as adults ( $t(1212) = 3.22, p = .0013$ ), were rated as better mentally adjusted in 1940 ( $t(1335) = 2.37, p = .02$ ), and had a higher childhood IQ ( $t(1407) = 3.55, p = .0004$ ) than those who completed fewer activity assessments. There were no other differences between the two groups.

## Growth Curve Modeling

### Establishing the baseline model.

Preliminary plots of the data revealed both intra- and inter-individual variation across time (see [Figure 2](#)). [Table 4](#) summarizes the baseline models for the full sample and separately by sex. First, a baseline no-growth model was fit ([Table 4](#), Model A). Second, an unconditional linear growth model was fit (i.e., the linear effect of age; [Table 4](#), Model B), which resulted in a vast improvement over the unconditional means model ( $\Delta\chi^2(3) = 546.3, p < .0001$ ); 19.9% of the within-person variance was explained by including age in the model. Third, an unconditional quadratic model was fit (i.e., the quadratic effect of age; [Table 4](#), Model C), which resulted in an improvement of model fit ( $\Delta\chi^2(3) = 91.9, p < .0001$ ); 7.9% of the within-person variance was explained by including the quadratic term. Although the average quadratic change was non-zero, the variance of the random quadratic effect ( $\zeta_{2i}$ ) was non-significant ( $p = .99$ ); therefore no between-person predictors of quadratic change in physical activity were included in subsequent conditional models. Thus, when predictors were subsequently added to the model, variables could predict the initial level of activity (at age 29) and the linear decline as people age, but not quadratic variation.

*Testing for sex differences.* As expected, males were more active than females at each assessment (1936:  $t(1077) = 4.86, r = 0.15$ ; 1940:  $t(1082) = 4.58, r = 0.14$ ; 1950:  $t(1171) = 7.05, r = 0.20$ ; 1960:  $t(1102) = 6.96, r = 0.21$ ; 1972:  $t(843) = 5.82, r = 0.18$ ; all  $ps < .0001$ ). The baseline quadratic model was similar for males and females (see [Table 4](#)). Sex was a significant predictor of level but not linear slope, and there was no age-by-sex interaction. For the predictors, there was a significant interaction between sex and cheerfulness, such that males who were rated low on cheerfulness were more active at age 29 than males rated high on cheerfulness, whereas females rated low on cheerfulness were less active at age 29 than women rated high on cheerfulness. No other sex-predictor interactions were evident. As different predictors may be relevant for males and females, analyses were performed separately by sex.

*Individual predictors.* Although the age variables explained some of the variation within individuals, significant variance across individuals remained. [Table 5](#) and [Table 6](#) (for males and females respectively) summarize model estimations for each predictor and control variable entered individually, and [Figure 3](#) plots average trajectories for an individual high and low on seven significant predictors (child energy and sociability, and adult extraversion, neuroticism, self-rated health, mental adjustment, and BMI).

For males, child energy, child sociability, adult neuroticism, and adult extraversion significantly predicted both MET activity level and linear change at age 29. Males who were rated as higher on energy or sociability as children, and males who were more extraverted or less neurotic as adults reported higher levels of activity at age 29, but the trajectory evidenced a steeper decline at age 29, such that by age 61, they displayed fairly similar levels of activity as males who were less energetic, less sociable,

less extraverted, or more neurotic. Birth weight, child activity (parent report), BMI, self-rated health, mental adjustment, and social ties predicted the level effect. Males who weighed more at birth, engaged in more active pastimes as children, weighed more as adults, rated themselves higher on physical health, were better mentally adjusted, or had more social ties were also more active at age 29. Child interest in active pastimes (child report) predicted both the level and linear effects, such that men who enjoyed being active as a child were more active at age 29, but declined more at age 29, such that by age 61, they displayed fairly similar levels of activity as males who were less active as children.

Females who were rated as more energetic or sociable as children were more active at age 29. Neuroticism marginally predicted less activity. Puberty and child activity (parent and child report) predicted the activity level effect, such that women who reached puberty at a later age or were more active as children were also more active at age 29. Early adult self-rated health and mental adjustment predicted both the level and linear effects, such that women with good health or mental adjustment were more active at age 29, but declined more at age 29, such that by age 61, they displayed fairly similar levels of activity as females who were less healthy or less adjusted.

*Including multiple predictors.* Multivariate models were then estimated, to determine the individual effect of one predictor on the activity growth curve, holding the other variables in the model constant and to control for baseline characteristics. Five combined models were estimated: (a) the six child personality variables (cheerfulness, conscientiousness, sociability, energy, motivation, and permanency of mood); (b) the four adult personality variables (agreeableness, conscientiousness, extraversion, and

neuroticism); (c) the child personality variables controlling for significant child control variables (birth weight, age of puberty, child activity); (d) the adult personality variables controlling for significant adult control variables (health, BMI, mental adjustment, social ties); and (e) a final model that included all significant child and adult personality and control variables. Results for the personality variables were consistent with the individual predictors, and including the control variable did not significantly alter personality-activity relations.

For males, childhood energy predicted the level effect, and childhood sociability and adult neuroticism and extraversion predicted both the level and slope effects. Including the control variables, only birth weight remained significant; physical health, mental adjustment, BMI, social ties, and child activity were reduced to non-significance. In the final combined model, child energy and sociability, adult neuroticism and extraversion, and birth weight accounted for 6.1% of the intercept variance and 5.2% of the linear variance. For females, childhood energy predicted the level effect; no other child or adult personality variables were significant. When the control variables were included, age of puberty predicted the level effect, and adult self-rated health predicted both the level and slope effects; child activity and mental adjustment were reduced to non-significance. In the final model, child energy, age of puberty, and adult self-rated health accounted for 4.6% of the intercept variance and 1.1% of the linear variance. In each case, significant individual variation remained.

*Very active individuals.* In a supplemental analysis, 35 individuals (30 M, 5 F) who reported very high MET ratings (greater than three standard deviations above the mean) on one or more of the activity variables across time were removed and models

were re-fit with the remaining 1,374 participants. The highly active individuals were more likely to be male, less neurotic, less agreeable, and reached puberty at a later age. Excluding these high-activity individuals from the growth curve analyses, the average MET activity level at age 29 was 3.17 versus 3.23, and the linear effect was -0.005 versus -0.007. Including the predictor variables, the pattern of results remained essentially unchanged. These patterns support the main analyses and suggest that the relations reported above are not merely driven by a few extreme individuals.

### **Predicting Health and Well-being Outcomes**

Average activity levels for each year, the number of activities reported each year, and empirical Bayes estimates of the intercept and slopes (from the growth analyses) were used to predict health and longevity outcomes across the lifespan. Due to multicollinearity, each activity variable was tested independently.

#### Establishing the Activity Predictor Variables

The average MET values (used as outcomes in the growth analyses) were used as individual predictors of activity levels. In addition, the number of activities reported each year was considered. Although participants reported up to 17 activities, most participants reported five activities or less. Only a few individuals reported more than 10 activities; to reduce skew, the variables were recoded such that 10 = ten or more activities. For the empirical Bayes estimates (EB), the baseline quadratic growth model was run (with no predictors), and individual random values variance values for the intercept and slope were saved and used as predictor variables. That is, for each individual, a regression equation was estimated, based on that person's average activity

level at each assessment, with an intercept and slope unique to that individual. These values are estimated through an iterative process that finds the best fitting regression line for the individual, based both on the individual's scores and the overall average trajectory for the entire sample. The individual intercept and slope values can then be saved and used like other variables in a dataset (these are referred to as the EB intercept and slope in the proceeding results).

### Cross-sectional and Short-Term Relations

First, the EB intercept and slope and the 1936 and 1940 activity variables were correlated with 1940 physical health and mental adjustment, and the 1950 and 1960 activity variables were correlated with midlife health and mental adjustment to examine cross-sectional patterns. Results are summarized in [Table 7](#). In 1940, physical health related to the EB intercept and slope and the 1936 and 1940 levels of activity for the full sample and females, and the EB intercept for males. Mental adjustment related to the EB intercept. Number of activities reported was unrelated to health and adjustment. In 1950-60, activity levels related to both physical health and mental adjustment. In addition, number of activities was positively related to better mental adjustment in females.

Hierarchical linear regression was then used to predict midlife physical health and mental adjustment from the 1936, 1940, and 1950 variables, as well as the EB intercept and slope variables, controlling for age. In males, midlife physical health was predicted by the EB intercept, activity in 1940 and 1950, and the number of activities reported in 1950. Controlling for 1940 health, adjustment, and personality, only the number of activities reported in 1950 remained significant. Mental adjustment was

predicted by the EB intercept and slope, and activity in 1936, 1940, and 1950. All except 1950 activity remained significant after controlling for 1940 health, adjustment, and personality. In females, physical health was predicted by the EB intercept, activity in 1936 and 1940, and the number of activities reported in 1940. Midlife mental adjustment was predicted by the EB intercept, and activity in 1940 and 1950. In contrast to the males, none of these remained significant predictors of midlife physical health or mental adjustment when 1940 health, adjustment, and personality were included.

### Predicting Older Age Health and Longevity

Hierarchical linear regression was then used to predict healthy aging in 1986 (physical health, mental well-being, social competence, and productivity), and survival analyses were used to predict survival through 2008 from the activity predictors. Results for the individual physical activity predictors (controlling for age, and sex in the full sample) are summarized in [Table 8](#). Average activity in 1940 and 1960 predicted SWB in 1986 for the full sample and females. Activity levels in 1960 and 1972 predicted physical health in 1986 for women. Number of activities reported each year predicted social competence and productivity for the full sample, males, and females.

The 1940 control variables were also individually entered into regression equation, and then significant variables were entered simultaneously. For the 1986 physical health outcome, the results showed that BMI, self-rated health, adjustment, and personality were significant predictors, accounting for 15.4% of the variance (males:  $R^2 = 0.12$ ; females:  $R^2 = 0.24$ ). For the SWB outcome, health, adjustment, less alcohol use, and personality were significant predictors, accounting for 18% of the variance (males:  $R^2 = 0.12$ ; females:  $R^2 = 0.19$ ). For the social competence outcome, less

alcohol use, social ties, and personality were significant predictors, accounting for 16.3% of the variance (males:  $R^2 = 0.11$ ; females:  $R^2 = 0.12$ ). For the productivity outcome, less alcohol use, social ties, and conscientiousness were significant predictors, accounting for 12.8% of the variance (males:  $R^2 = 0.15$ ; females:  $R^2 = 0.08$ ).

A final set of models was then estimated that combined the significant activity and 1940 control variables for each outcome. Including the control variables reduced the predictive ability of all the activity variables. Activity in 1940 remained a significant predictor of 1986 SWB for women ( $\beta = 0.09$ ,  $t(244) = 2.41$ ,  $p = .02$ ), and 1960 activity remained a significant predictor of physical health ( $\beta = 0.13$ ,  $t(266) = 2.13$ ,  $p = .03$ ). The number of activities reported remained significant predictors of social competence and productivity for the full sample, males, and in some cases, females. For males, the number of activities in 1936 became a significant predictor of physical health ( $\beta = 0.08$ ,  $t(303) = 2.22$ ,  $p = .03$ ), and surprisingly, 1936 activity became a significant inverse predictor of productivity ( $\beta = -0.06$ ,  $t(271) = -2.24$ ,  $p = .03$ ) and. Significant results are summarized in [Table 9](#).

A mediation model was then tested, with the midlife variables (health, mental adjustment, alcohol use, hardships, social ties, and educational attainment) tested as potential mechanisms. As noted in [Table 9](#), health and mental adjustment predicted 1986 physical health and SWB. Alcohol use (negatively), social ties, and education predicted increased social competence and productivity. Combining the significant activity and midlife predictors, 1936 activity and 1940 number of activities remained marginal predictors of physical health for the full sample and females. For SWB, activity

predictors were reduced to non-significance. For social competence and productivity, relations with the number of activities reported remained essentially unchanged.

For mortality risk, first, the activity variables were used to predict mortality, controlling for age (and sex, in the full sample model). The number of activities reported was a stronger predictor than level of activity. Specifically, lower mortality risk was predicted by number of activities in 1940 (full sample: relative hazard [*rh*] (1242) = 0.95,  $p = .02$ ; males:  $rh(691) = 0.98$ ,  $p$  ns; females:  $rh(549) = 0.92$ ,  $p = .005$ ), 1960 (full sample:  $rh(1123) = 0.94$ ,  $p = .02$ ; males:  $rh(613) = 0.93$ ,  $p = .04$ ; females:  $rh(508) = 0.95$ ,  $p$  ns), and 1972 (full sample:  $rh(932) = 0.91$ ,  $p < .0001$ ; males:  $rh(494) = 0.91$ ,  $p = .003$ ; females:  $rh(436) = 0.91$ ,  $p = .005$ ). Activity level in 1960 activity also predicted lower risk for females ( $rh(502) = 0.84$ ,  $p = .003$ ), and 1972 activity was marginally protective ( $rh(397) = 0.84$ ,  $p = .06$ ). Then, significant 1940 control variables (health, alcohol use, conscientiousness, and neuroticism) were added to the model. Activity level in 1960 and 1972 became significant for the full sample, and remained significant for females. Number of activities in 1960 was no longer significant for the full sample. Relations did not change for number of activities reported in 1940 and 1972. Finally, the midlife variables (midlife health, alcohol use, social ties, and education) were added. Although the health variables explained part of the variance, for females, the number of activities reported remained a significant predictor of lower mortality risk.

### Supplemental Analysis of Activity Patterns

To further understand activity patterns and health outcomes, a supplemental analysis was conducted in which the EB intercept and slope estimates were used to group participants into four different activity patterns. For the intercept estimates, a

negative sign indicates that the individual had a lower activity level at baseline than the average for the sample, and a positive sign indicates that the individual had a higher activity level than the average for the sample. For the slope estimates, a negative sign indicates that the individual's activity declined over time and a positive sign indicates that the individual's activity increased over time.

- Group 1: low-decline (negative EB intercept, negative EB slope)
- Group 2: high-decline (positive EB intercept, negative EB slope)
- Group 3: low-increase (negative EB intercept, positive EB slope)
- Group 4: high-increase (positive EB intercept, positive EB slope).

Average values for the four healthy aging variables and length of life were compared across groups using a one-way ANOVA. It was expected that groups 1 and 2 would die earlier on average, and that groups 3 and 4 (representing continual physical activity) would live longer on average. For the four healthy aging variables, there were no significant differences across groups. For age of death, there was a significant difference,  $F(5,1403) = 10.68, p < .0001$ . Tukey post hoc tests indicated that group 1 was significantly lower (i.e., died at a younger age on average) than all other groups. Group 4 was significantly higher than group 2. [Figure 4](#) plots the means by group.

In addition, to consider possible moderators of activity-death relations, subsamples of active, long-lived males and females were compared to inactive, short-lived males and females. Long life was defined as 93+ and 95+ years for males and females respectively, and short life was defined as dying by age 65 for males and age 75 for females (the different ages are due to length of life differences between males and females). For both sexes, active individuals reported moderate or vigorous activity at

each assessment, and inactive individuals reported low activity at each assessment. For males, the active, long-lived group experienced better health and adjustment in early and middle adulthood, was more conscientious, and had more social ties in 1940. For females, active, long-lived individuals were more conscientious and less neurotic. This supports the role of personality, and suggests that social ties may play a role for men; this should be further investigated in future studies.

### **Joint Growth-Outcome Analyses**

Finally, using MPlus, several models were estimated that simultaneously estimated the growth model parameters and predicted the aging and death outcomes, using the full sample. Models were estimated for both the average activity levels reported and the number of activities reported each year. First, to replicate the analyses performed in SAS, baseline mean, linear, and quadratic models were estimated for the five activity variables.<sup>8</sup> The linear and quadratic models were then used to predict late life outcomes (1986 healthy aging and mortality risk), first individually (with only the activity and outcome variables, controlling for age and sex), and then including several 1940 control variables (physical health, mental adjustment, social ties, conscientiousness, neuroticism, extraversion, and agreeableness). Participants with missing data on the control variables were excluded; analyses included 616 participants for the healthy aging models and 1,143 participants for the survival models.

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<sup>8</sup> For the average activity level, a direct quadratic model had convergence problems. Following the results in SAS, the quadratic variance was fixed to 0. Models then converged without a problem. For the number of activities reported, a quadratic model was problematic. Upon examining the means, it appeared that the number reported increased through 1960, and then decreased. The centering age was changed to 49 (average age in 1960), and the quadratic model then worked well.

Results are summarized in [Table 10](#). Personality, health, mental adjustment, and social ties predicted health outcomes and were subsequently included as controls in the joint activity variable models. For average activity, in the linear model, the intercept growth parameter predicted survival, such that more active individuals had a lower mortality risk. In the quadratic model, the slope positively predicted social competence and productivity, such that individuals with less decline in activity were more socially competent and productive in older age. For number of activities, in both the linear and quadratic models, the linear growth parameter predicted survival, such that those who declined less were at lower mortality risk. Both the intercept and linear parameters predicted health, social competence, and productivity, such that individuals who were more active or who declined less had better health outcomes.

### **Study 1 Summary of Findings**

The first study aimed to recast the Terman data to examine activity patterns over time, determine an average pattern of physical activity, explore personality and psychosocial predictors of individual variation, and examine health and longevity outcomes across the lifespan.

The qualitative data were successfully recast into quantitative reports of activity across five assessments. From this, an average pattern was determined for the sample. On average, a quadratic model fit best, with decelerating decline with age. However, there was a lot of individual variation. This variation is what subsequent analyses tried to explain and was used to predict health outcomes measured across adulthood. As expected, the biggest difference was sex-- males were more active at each

assessment. Although both sexes demonstrated a quadratic growth model, females varied less than males. Personality predictors were stronger for males, whereas health variables were stronger for females. For males, child energy, sociability, and interest in active pastimes (as reported by the child), and adult neuroticism and extraversion predicted level and slope, and birth weight, child activity (as rated by the parent), BMI, self-rated health, mental adjustment, and social ties predicted the level effect. For females, adult health and mental adjustment predicted the level and slope, and child energy, sociability, activity (child and parent report), and puberty predicted the level effect.

For predicting outcomes of health, well-being and longevity, multiple variables were considered – the growth parameters (level and slope), average activity each year, and also the number of activities reported. The latter may better represent social involvement, much like the productivity measure for older age health. For cross-sectional and short-term health outcomes (1940, midlife health and adjustment), activity levels predicted better health and adjustment. The slope was negatively related to health and well-being, such that individuals who declined less experienced better health outcomes. Later activity levels (1960 and 1972) predicted physical health, but only for the females. Activity levels in 1940 and 1960 activity predicted late-life SWB, and activity levels were not related to social competence or productivity. The number of activities did not relate to physical health and well-being but were strong predictors of social competence and productivity. For survival, 1960 and 1972 activity levels predicted longer life for females, whereas number of activities predicted longer life for males. In the joint analyses, higher activity levels and less decline predicted longer life,

whereas the number of activities predicted physical health, social competence, and productivity.

Comparing groups of high, low, increasing, and decreasing activity, individuals who were most active or increased activity across the life lived longer than those who were inactive or decreased activity, lending support to the idea that it is a consistent pattern of moderate activity that is most protective. Supplemental analyses add some support to a social pathway – active, long-lived males had more social ties in early adulthood than short-lived, inactive males.

### **Study 2: The Personality, Health and Behavior (PHAB) Study**

The Terman data offer a full lifespan consideration of health, behavior, personality, and social networks over time. The sample however is a single cohort born in the early 20<sup>th</sup> century. Participants were highly intelligent, and the sample is relatively homogenous in terms of class and ethnicity. The second study examined psychosocial and individual historical factors, with a particular focus on personality, that distinguish different physical activity patterns, using a contemporary, ethnically diverse cross-sectional sample.

A survey based on several well-established measures was developed and administered online. Questions focused on personality, individual history, and social factors that may influence preference for physical activity and related health and well-being outcomes. Participant activity levels were classified, and rational and empirical analyses were combined to identify a set of traits that distinguish between active and inactive individuals. Active and sedentary individual were then compared on health and

activity outcomes, with special consideration of the individual, behavioral, social, and interactive factors relevant to different levels. The second study had three purposes:

- 1) to empirically determine a cluster of personality traits that distinguish active and inactive individuals;
- 2) to examine individual, social, and health-related correlates of typical activity patterns; and
- 3) to help validate the activity measure from the Terman sample.

## **Study 2 Method**

### **Participants**

Participants were recruited from various venues to obtain a cross-section of individuals with variation in normal activity levels, although recruitment targeted on undergraduate students and young adult community members. To allow comparisons with the Terman sample, participation was limited to young adults living in California.

- a) *Undergraduates*: As is commonly done in social and personality studies, undergraduate students from the UCR psychology pool and upper division psychology students from La Sierra University were recruited. Although college students are typical for social psychology studies, they are less common in physical activity studies. If health habits that are established in young adulthood have long-term impact, this may be the most important group to target for intervention. UCR students earned one unit of credit and LSU students earned extra class credit for participating in the study.

b) *Community members*: To capture individuals expected to be high in activity, individuals were recruited from local running clubs and online forums. To recruit less active individuals, fliers were left at local businesses, and online announcements on Facebook and other social networking sites invited people to participate in the study. To encourage participation, participants were entered into a drawing for one of four \$75 cash prizes.

Due to cost and time restraints, recruitment efforts focused on people in the local Inland Empire communities (in and around Riverside and San Bernardino), although online invitations reached individuals in central and northern California. Results may not generalize to other people in other places, but UCR, Riverside, and the surrounding areas are highly diverse, including a broad range of ethnicities<sup>9</sup>. Personal and social factors may highlight where disparities do exist.

Although participants from a broad age range (18 to 50 years old) responded, most participants (90%) were young adults (< 30 years old). As these ages were most similar to the Terman participants in the 1936 and 1940 assessments, the 38 individuals who were over 29 years old were removed from the sample. In addition, after examining responses it was apparent that 31 participants did not complete the entire survey and did not have sufficient data on the variables of interest, so these individuals were also excluded from the study.

The final sample consisted of 307 individuals (109 males, 178 females, 20 unknown). The mean age was 19.8 years old ( $SD = 2.16$ ); 207 participants were

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<sup>9</sup> Despite recruitment efforts, the sample is most likely is biased. The participants volunteered to complete the survey. To be more representative, a shorter survey is necessary; the length of the survey turned many away. This was a good learning experience for future recruitment efforts.

undergraduate students; 100 participants were community members. The sample was ethnically diverse (33% Asian-American; 24% Caucasian; 23% Latino; 5% African American; 15% Other/Unknown).

### **Procedure Overview**

Participants completed an online survey at their convenience. Responses were collected over a three-month period through SurveyMonkey.com, an online survey assessment program for designing and administering surveys. The survey took between 30 and 60 minutes to complete. Upon completion, participants were debriefed, thanked for their time, entered into the drawing, and directed to a website with study updates, weekly health tips, and other interesting links.<sup>10</sup> All procedures were approved by the UCR institutional review board.

### **Measure: Personality, Health, and Behaviors (PHAB) Survey**

All data was collected through a computer-based survey (see [Appendix 4](#) for a printed copy). The survey included demographic and background information, physical and mental health, reports on physical activity and other health-related behaviors, social relationships, and personality. The survey was a hybrid of several questionnaires, with questions chosen that appeared relevant to the constructs and theories of interest, have

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<sup>10</sup> [http://student.ucr.edu/~mkern001/The\\_PHAB\\_Study/PHAB\\_Study\\_Updates/PHAB\\_Study\\_Updates.html](http://student.ucr.edu/~mkern001/The_PHAB_Study/PHAB_Study_Updates/PHAB_Study_Updates.html)

shown reliability and validity in other studies, and attempted to balance participant burden with a desire for completeness.<sup>11</sup>

The survey included items from other studies to allow cross-study comparisons in the future. In particular, items came from the Terman Life Cycle Study, the Hawaii Personality and Health Cohort Study (HPHCS), the World Health Organization (WHO), and the San Diego Health and Exercise Study (SDHES). Items were chosen from the Terman data to help validate the archival measures. The Hawaiian study includes many of the social and personality measures from the Terman study, is ethnically diverse, and includes an extensive array of physical, mental, social, and personality measures (see Hampson et al., 2001 for an overview). Many of the questions on lifestyle, health, and behaviors came from this study. Questions on quality of life were added from the WHO-Brief Scale (WHO, 1998); this scale has been used to assess health-related quality of life around the world and is commonly included in studies of physical activity and health. Details on current and past physical activity followed work by Dr. James Sallis and colleagues, one of the prime researchers on the social influences and correlates of physical activity. [Appendix 5](#) details the items and sources, and types of items are summarized below, with the source in parentheses.

*Physical and mental health.* As is typically done in surveys of health, a 5-point item assessed current health (“in general, how is your health?”). Participants reported their energy and vitality (Terman study). In addition, participants reported satisfaction with health, current and past medical conditions and experiences, pain, and health care

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<sup>11</sup> The survey probably erred on the side of including too much. In the future, I would use a shorter survey that is less comprehensive and focuses solely on the questions of interest. The analyses presented here tap only part of the questions asked; much more can be done with the data in the future.

access and use (Hawaiian study). Mental health measures included overall life satisfaction and quality of life (WHO-QOL); happiness, satisfaction across various life domains, and tendency toward worry (Terman study); and depression and stressful life events (modified Hawaiian study).

*Physical activity.* The survey included an extensive section on physical activity, including current physical activity, activity history (activity over the past year, childhood experiences, injuries) and beliefs about physical activity (perceived benefits and barriers). Most questions came from the San Diego study (Sallis et al., 1989). In addition, to validate the Terman activity measure, participants freely reported their leisure time activities and hobbies.

*Personality.* Personality traits assessed in the Hawaiian study, which were modified from Goldberg's 100 adjective checklist (Goldberg, 1992), were included, as were trait ratings and questions used in the Terman sample. In addition, as a core part of the analyses aimed at empirically determining which traits best distinguish active and inactive people, a set of adjectives was added that, at face value, seemed to describe active people.<sup>12</sup> Twenty-eight potentially-relevant adjectives were rationally identified and included with the other traits (see [Appendix 6](#)).

*Social context.* Two aspects of the social context were included: the immediate environment and social relationships. For environmental influences, questions on environment health, safety, and how active people in the neighborhood are were included (WHO-QOL, San Diego study). For social relationships, questions on social

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<sup>12</sup> To create a set of descriptors, existing personality and temperament measures were consulted, and the Merriam-Webster dictionary was searched for potential synonyms and antonyms.

network size, relationship quality, and how much friends and family supports being physically active were included (Hawaiian & San Diego studies).

*Demographic and background information.* Basic demographic information included sex, age, ethnicity, marital status, occupation, income, and education.

## **Variable Reduction**

The analyses presented here only used items relevant to the main aims and hypotheses of the present study. Most of the analyses involved reducing the items into a small number of reliable composite variables, which were then used in the main analyses. Descriptive statistics are summarized in [Table 11](#) and are graphically displayed in [Figure 5](#).

### Health and well-being

Measures of physical and mental health included:

- a) *Physical health:* On a 5-point scale, participants indicated their general health in the past year, their current health compared to the past, energy level, and satisfaction with their physical health. These items were summed to create a composite physical health score (4 items,  $\alpha = 0.77$ ).
- b) *Health problems:* Participants reported how often health problems or pain interfered with their lives, any medical or chronic conditions, use of medication, and health care utilization. Items were standardized and summed, and a constant was added to remove negative values (7 items,  $\alpha = 0.72$ ).
- c) *Life satisfaction:* Using variables from the Terman and Hawaii studies, participants reported their level of satisfaction across 10 areas of life (school,

work, achievements, income, hobbies, friends, social contacts, family, friends, body), their overall satisfaction with life, and the extent to which they felt they have lived up to their potential, on a 5-point scale. Items were averaged to create a composite life satisfaction score (12 items,  $\alpha = 0.82$ ).

- d) *Subjective well-being (SWB)*: As a more general measure of mental health, self-reported happiness, overall quality of life, ability to relax, satisfaction with health, extent to which they have lived up to their potential, satisfaction with life, and tendency toward worry (reversed) were averaged to create a subjective well-being composite score (7 items,  $\alpha = 0.71$ ). Note that this variable overlaps with the physical health and life satisfaction composite variables so it is considered as a separate but conceptually important outcome.
- e) *Depression*: Using a measure from the Hawaiian study, participants reported on a 7-point scale the extent to which they were bothered by depressive symptoms (e.g., “had trouble completing normal activities”; “felt depressed”). Items were summed to create a composite depression score (13 items;  $\alpha = 0.85$ ).

### Covariates

Gender, age, ethnicity, and body mass index (BMI, calculated from reported height and weight) were included as covariates.

### Personality: The Big Five

Participants rated themselves on 128 adjectives with a 7-point scale (1 = very inaccurate, 7 = very accurate). Principal axis factoring with varimax (orthogonal) rotation was used to define the Big Five factors. The final traits that loaded on each factor were:

- *Conscientiousness* ( $\alpha = 0.86$ ): efficient, organized, persistent, planful, practical, productive, self-disciplined, systematic
- *Neuroticism* ( $\alpha = 0.83$ ): complaining, emotionally stable (reversed [r]), fearful, fretful, moody, nervous, seclusive, temperamental
- *Extraversion* ( $\alpha = 0.83$ ): assertive, bold, energetic, extraverted, quiet (r), shy (r), socially confident, talkative
- *Agreeableness* ( $\alpha = 0.81$ ): cold (r), considerate, cooperative, harsh (r), kind, sympathetic, warm, unsympathetic (r)
- *Intellect* ( $\alpha = 0.86$ ): creative, curious, deep, imaginative, intellectual original, uncreative (r), unintellectual (r)

The trait ratings were also used to define an active personality composite variable (described below).

### Individual Factors

Additional individual characteristics included:

- a) *Drive for ambition and success*: Using questions from the Terman study, participants indicated how ambitious they perceived themselves to be (compared to peers) in terms of work, achievements, advancement, and financial gain, and their need to succeed as a leader, in work or school, financially, and in their social lives on a 5-point scale (1 = much less, 3 = about the same, 5 = much more). Items were summed to create a drive for success score (9 items,  $\alpha = 0.82$ ).
- b) *Perceived benefits and barriers of exercise*: Using questions from the Hawaiian study, participants rated the benefits they see in exercising (e.g., "I will look

better”; “I will be less depressed”; “I will lose weight) on a 5-point scale (-2 = strongly disagree, 0 = neutral, +2 = strongly agree). They also rated how often potential barriers stop them from exercising (e.g., “lack of time”; “bad weather”; “feeling self-conscious about how I look”) on a 5-point scale (1 = never, 5 = all the time). Responses were summed to create overall perceived benefits (13 items) and barriers (17 items) scores.

- c) *Stressful life events*: Following the Hawaiian study, participants reported whether a series of stressful events (e.g., “you suffered a serious injury, illness, or assault”; “a close family friend or relative died”; “you had major financial problems”) had ever happened to them, and if so, when. Events were coded according to the recency of occurrence (5 = within the past year, 4 = 1-2 years ago, 3 = 2-3 years ago, 2 = 3-5 years ago, 1 = over 5 years ago, 0 = never), and then summed to create a total stressful life events score.
- d) *Perceived control*: Following the Hawaiian study, control was measured by 7 items developed by Pearlin and Schooler (1978). The items tap perceptions of control in life in general (e.g., “I have little control over the things that happen to me”; “there is little I can do to change many of the important things in my life”). Items were rated on a 7-point scale (1 = strongly disagree, 4 = neutral, 7 = strongly agree), and were summed to create a composite perceived control score (7 items,  $\alpha = 0.78$ ). Note that with the wording of the questions, higher scores indicate perceptions of *less* control.

### Social Factors

Social factors included:

- a) *Local environment*: Participants reported the extent to which they live in a safe environment on a 5-point scale (1 = not at all, 5 = very much). Additionally, participants reported how often they see others in the neighborhood running, jogging, biking, walking, or otherwise being physically active (1 = never, 5 = all the time).
- b) *Family and friend activity support*: Participants reported the extent to which family or friends encourage them to exercise, offered to exercise with them, and actually exercised with them on a 5-point scale (1 = never, 5 = all the time). Responses were summed to create an activity support score (3 items,  $\alpha = 0.83$ ).
- c) *Social integration and relationship quality*: Participants reported the number of relatives, siblings, and friends; these were weighted by the closeness of ties (intimate, casual, acquaintance) and summed to create a social integration score. Participants also reported satisfaction with friends, family, and other social contacts, the extent to which they can rely on others to be there for them, and how alone they feel (reversed). Items were combined to create an average relationship quality score (6 items,  $\alpha = 0.81$ ).

### Activity History

Several items were refined to examine the role of prior experiences. Although these questions were reported retrospectively and may be biased by current experiences, they do provide more information than simply ignoring the past.

- a) *Child and adolescent activity*: Participants reported how active they were as an adolescent compared to peers, and how much they enjoyed being physically active in elementary school, junior high, and high school. Items were averaged to

create a child activity score (4 items,  $\alpha = 0.81$ ). In addition, participants reported whether they had participated in sports in high school (0 = no, 1 = yes).

- b) *Injury*: Participants reported whether they had ever experienced a period of prolonged injury as a child, as a teen, and as an adult, and whether their current activity was limited by major illness or injury. If the participant reported injury during any of these periods, they received a 1, otherwise they received a 0.

### Physical Activity

Several measures of physical activity were refined as indicators of activity level:

- a) *Average leisure time activity*: To validate the Terman activity measure, participants freely responded to the question “what do you do in your leisure time?” Using the coding scheme from the Terman study ([Appendix 2](#)), undergraduate research assistants coded each item mentioned, and MET values were assigned.<sup>13</sup> Participants listed up to 17 different activities ( $M = 4.15$ ,  $SD = 2.72$ ). MET values were averaged to create a composite leisure time activity variable.
- b) *Most often activities*: Participants then listed up to eight activities that they participate in most often. Each activity was assigned a MET value, and an average value was computed. [Appendix 7](#) lists the activities mentioned with corresponding MET values.
- c) *Typical effort level*: For each activity listed, participants indicated their normal level of exertion on a 6-point scale (1 = sedentary activity with little movement, 6

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<sup>13</sup> In some cases, participants mentioned activities not listed on the original code sheet. For these, new codes and corresponding MET values were assigned. Added activities were: yoga (2.5 METs), shopping (2.3 METs), skateboarding (5.0 METs), aerobic classes (6.5 METs), frisbee (3.0 METs), and motor-cross (4.0 METs).

= strenuous activity with breathlessness and a lot of sweating). Responses were averaged to create a composite effort variable.

- d) *Self-rated fitness*: Participants also self-rated their level of fitness. Participants rated how fit, how active, how flexible, and how strong they were compared to peers on a 5-point scale (1 = much less, 3 = about the same, 5 = much more). Items were averaged ( $\alpha = 0.82$ ) to create an overall self-rated fitness score.
- e) *Exercising for 20 minutes*: Participants indicated how often during a typical week that they exercise for 20 minutes without stopping. Responses were reduced to a 4-point scale (1 = none, 2 = 1 to 2 times, 3 = 3-5 times, 4 = over 5 times).
- f) *Rated activity level*: All questions on physical activity (leisure time activities, most often activities, effort level, time use) were compiled, and trained RAs were instructed to classify each participant on their overall level of activity on a 7-point scale (1= completely sedentary, 7= very active). Three RAs rated each participant; ratings were averaged to create a “rated activity” score (average inter-rater reliability  $r = 0.91$ ).

These six measures were combined to create a composite physical activity score ( $\alpha = 0.87$ ). Items were standardized and averaged, and then a constant was added to eliminate negative values.

## **Data Analysis**

### Analytic Strategy Overview

Data analyses involved four parts. (1) Using cluster analysis, participants were clustered into three groups representing high, moderate/mixed, and low levels of

physical activity. Clusters were then compared across the different predictor and control variables (defined above), using contrast *t*-tests. (2) Through a combination of rational assessment, inter-item correlations, and factor analysis, a group of traits that distinguish active and inactive individuals was selected. (3) Regression and path analyses and structural equation modeling (SEM) were used to evaluate a model predicting physical activity and health from individual and social factors. (4) To help validate the Terman activity variables, a set of variables that were measured in both the Terman sample (Study 1) and this sample (referred to below as the PHAB sample) was compiled. Then, correlations between personality, activity, and health variables were examined independently in each sample to see if the same pattern of results was apparent in the two samples.

### Cluster Analyses

First, using reports on the six physical activity variables (leisure time activity, most often activities, effort level, fitness level, frequency of exercising 20 minutes per week, and overall activity rating) cluster analyses grouped participants into clusters representing high, moderate and low levels of physical activity. Cluster analysis is a multivariate data reduction technique that aims to uncover a structure to the data and offers an objective way to quantify how things are structurally related (Hair & Black, 2000). Groups of people are identified based on their responses to a set of items, and then other variables in the dataset can be descriptively examined to describe the groups and understand differences.

There are two main types of cluster analyses: hierarchical and non-hierarchical. In the hierarchical method, a stepwise procedure combines or divides objects into

clusters. In the non-hierarchical approach, a set number of clusters is defined *a priori*, and then an iterative process groups the data into the specified number of clusters. This study used a K-means non-hierarchical approach, in which data are grouped into a pre-defined number of clusters (in this case, three: inactive, moderate, and active). A centroid (the mean of multiple objects) is calculated for each cluster. Data is then moved to try and minimize the distance between the value and the mean of the other values, and a new centroid is calculated. The computer essentially moves values around until each variable is closest to its respective centroid values, and no more movement occurs between the clusters.

Before starting the analyses, participants were randomly divided into two groups. Analyses were conducted with the first group, and then confirmed in the second. Although primarily a three-cluster solution was tested, 2, 4, and 5 clusters solutions were considered as well. Clusters were then compared across individual, social, and health variables using a series of contrast *t*-tests.

### Defining Active Personality Traits

One of the main goals of the study was to identify a set of traits that empirically distinguish active and inactive individuals. Rational and empirical analyses were combined to determine a set of traits that capture this construct. First, trained undergraduates rated all personality traits on how well the items describe active versus sedentary individuals. Traits that consistently were rated high (for activity) and low (for inactivity) were retained for further analysis, which involved two approaches. First, the traits were examined through correlation and factor analysis. Using the core traits “active” (to capture activity) and “inactive” (to capture inactivity), items that loaded on

factors with these traits were retained. A second set of analyses started with the activity clusters, and used *t*-tests to examine which traits distinguished between the active (cluster 3) and inactive (cluster 1) groups. The variables that best distinguished the groups were retained. Results from the two approaches were then combined to identify a final set of traits that successfully distinguished active and inactive individuals, both rationally and empirically. A composite personality variable was created, described, and correlated with the other individual, social, and health variables.

### Regression and SEM Analyses

Various models have been proposed linking physical activity, personality, and social factors. These models typically examine individual factors (e.g., self-efficacy, intentions, attitudes, and motivation) or social factors (e.g., social support, behavioral context, neighborhood elements) as predictors of physical activity, and have seldom considered the interaction (or fit) between the person and the situation. Studies have typically found that multivariate models explain 15 to 40% of the variance in physical activity (e.g., Adams & Mowen, 2005; Connor & Abraham, 2001; Godin & Connor, 2008; McNeill et al., 2006; Rhodes, Courneya, & Jones, 2005), leaving much unexplained variance.

To consider the active personality within these models, and to consider the interaction of individual and social factors, a model was tested using regression, path analyses, and structural equation modeling (SEM) techniques that predicted physical activity and health outcomes from personality, history, and social support for activity

(see [Figure 6](#) for the theoretical model tested<sup>14</sup>). Although in the model physical activity leads to health outcomes, it is important to note that this does not indicate causation. It is likely that health and activity influence one another in a bidirectional manner. The analyses presented here cannot distinguish direction between these possibilities, and so the analyses are best considered as a complement to the approach and findings of Study 1.

Paths were first tested using hierarchical linear regression, with variables added in a step-wise procedure: (a) sex as a baseline predictor (sex differences are typically found in physical activity research); (b) the composite active personality variable; (c) controlling for other individual aspects (perceived benefits and barriers, childhood activity); (d) social variables (support for being active, safety of environment); (e) interaction terms between active personality and the social variables; and (f) a final model which included the significant variables from prior models.

The model was then tested with path analysis and SEM, using MPlus 4.2 software. SEM is a multivariate technique that allows comparison of specific theories (Loehlin, 2004; Ullman, 2007). Models can be simple or complex. A benefit of the SEM approach is that both manifest (observed) and latent (unobserved) variables can be included, and error can be directly modeled. As psychological constructs rarely are measured without error, SEM is useful for considering more real-life relations. For the present study, using an SEM model allowed relations between the variables to be directly modeled, rather than simply looking at correlational or regression relations.

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<sup>14</sup> More complex models could easily be suggested. However, the goal of this study was on creating the active personality variable, not on modeling structural relations, thus this is merely a simplistic, primary look at these relations. Future work will consider this in more detail.

### Cross Study Comparisons

The final goal for the PHAB study was to help validate the Terman physical activity measure and findings. The Terman sample was assessed across long time periods, whereas the PHAB sample is a modern sample assessed cross-sectionally. The PHAB study includes more detailed measures of personality, health, and activity. If relations hold between the two, then it strengthens the validity of the findings from each sample.

To aid comparison, some items from the Terman sample were included in the PHAB study measure. For the PHAB study analyses, these items were then combined with items from other surveys to create more reliable scales. In this final analysis, personality, activity, and health relations were examined using the measures described above, and then with the smaller subset of Terman items.

- *Physical activity*: the composite activity variable in PHAB included the physical activity question from the Terman study (i.e., free response on leisure time activity). The same coding was used for both studies. The single item was strongly related to the composite variable ( $r = 0.77$ ).
- *Active personality*: In the PHAB survey, participants rated themselves on 12 personality-type items used in the Terman 1940 and 1950 assessment.<sup>15</sup> Along with the trait ratings described above, the undergraduate raters also rated how well each of these traits described an active person.<sup>16</sup> Five traits were rated as

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<sup>15</sup> Compared to peers, participants rated how well the following traits described them: healthy, high physical energy, prudence & forethought, mechanical ingenuity, will power & perseverance, desire to know, desire to excel, originality, impulsiveness, enjoyment of social contacts, persistence in accomplishing your ends, and driven by a particular life purpose.

<sup>16</sup> In creating the active personality variable, only the single adjectives were used (e.g., “energy”, “persistent”, “driven”), as these are comparable to other, more modern studies that include personality

describing an active person (healthy, energy, will power, desire to excel, persistence). Two traits, *desire to know* and *driven by a purpose*, were not identified by the raters but were strongly correlated with the active personality variable, and so they were also included. These seven items were summed to create a composite Terman-measured active personality variable ( $\alpha = 0.85$ ). This variable correlated  $r(278) = 0.60$  with the main composite active personality variable.

- *Other variables:* The Terman study included two items from the composite physical health scale: general self-rated health and energy. Each of these were highly correlated with the composite scale ( $r(304) = 0.79$  and  $0.73$ , respectively), and with one another ( $r(304) = 0.47$ ). Eight of the 12 items composing the life satisfaction variable came from the Terman data. A sub-scale of these variables was created ( $\alpha = 0.77$ ). The nine items comprising the drive for success scale came from the Terman data, but were measured in different years (1950 and 1960). Thus, two subscales were created (success: 5 items,  $\alpha = 0.79$ ; ambition: 4 items,  $\alpha = 0.79$ ). Conscientiousness, agreeableness, extraversion, and neuroticism were created through different means, but since a composite variable exists in each set, these were included in the comparisons.

Variable correlations were then computed in the both the PHAB study and in the Terman sample, and the pattern of results was qualitatively compared.

## Study 2 Results

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ratings. These additional items were included to extend things to the Terman sample, rather than as part of the main measure.

## Part 1: Activity Clusters

First, cluster analyses were used to distinguish three groups, based on activity levels (active, inactive, mixed). The three-cluster solution best captured the data. [Table 12](#) gives final z-score values and a plot of the six variables across the clusters.<sup>17</sup>

Descriptive statistics by cluster are presented in [Table 13](#). Two sets of contrast *t*-tests examined differences between groups. The first contrast tested a linear pattern, with increasing benefit from the low to moderate and moderate to high clusters. The second contrast compared high activity to low and moderate activity (cluster 3 vs. cluster 1 and 2). Contrast predictions and results are summarized in [Table 14](#). It was expected that higher levels of conscientiousness, extraversion, agreeableness, openness, perceived benefits, social, support for being active, social ties, relationship quality, safe environment, active neighbors, child activity, physical health, subjective well-being, and life satisfaction would relate to high levels of physical activity (contrast 1:  $\lambda = -1, 0, +1$ ; contrast 2:  $\lambda = -1, -1, +2$  for inactive, mixed, and active clusters respectively). It was expected that lower levels of neuroticism, more perceived barriers, injury, depression, less internal control, fewer stressful events, younger age, and higher BMI would relate to lower levels of physical activity (contrast 1:  $\lambda = +1, 0, -1$ ; contrast 2:  $\lambda = +1, +1, -2$ ).

In the first contrast (linear relation), the data followed the predicted pattern for conscientiousness, extraversion, neuroticism, perceived benefits, barriers, and control, support for being active, relationship quality, child activity, injury, BMI, sex, and all of the health and well-being variables. In other words, more physical activity related to

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<sup>17</sup> Analyses were performed with half the sample (randomly selected), and then confirmed in the second half. Results replicated across both groups, so results are presented for the full sample only.

increases in the positive variables (e.g., conscientiousness, well-being, perceived benefits) and lower levels of negative variables (less neuroticism, fewer barriers, lower BMI). In the second contrast (moderate and low compared to high activity), the same pattern appeared, except conscientiousness and relationship quality were non-significant. Comparing the two contrasts, the linear pattern (contrast 1) better predicted conscientiousness, neuroticism, benefits, support for being active, relationship quality, SWB, life satisfaction, depression, and sex. The active vs. inactive/moderate pattern (contrast 2) better predicted extraversion, barriers, perceived control, child activity, injury, physical health and BMI.

## **Part 2: Empirically Defining Active Personality Traits**

Second, rational and empirical analyses were combined to determine a set of personality traits that distinguished active and inactive individuals. Traits were identified rationally through undergraduate trait ratings, and empirically through correlations, factor analysis, and comparing active and inactive clusters. Results were combined to determine a final set of traits.

### Active trait ratings

Using the 128 self-rated personality traits, five trained undergraduate research assistants rated each adjective on how well it describes an active or inactive individual, using a 7-point scale (1 = completely does not describe an active/inactive person, 4 = neutral, 7 = completely describes an active/inactive individual). Mean ratings were compiled (average inter-rater reliability  $r = 0.90$ ), and 38 traits with the highest (best describe an active person) and lowest (best describes an inactive person) ratings were retained for further analysis. Of the 38 traits, three items were consistently rated as best

capturing an active individual: active, athletic, and energetic. In addition, three items were rated as capturing inactivity: idle, lethargic, and lazy.

Inter-item correlations were computed among the 38 traits and traits that were significantly related to these six variables were retained for further analysis. An exploratory factor analysis was performed on the 38 traits, suggesting four factors. Five traits did not load well on any of these factors. The strongest relations came from 13 traits-- active, achievement-oriented, ambitious, dedicated, determined, diligent driven, energetic, goal-oriented, persevering, persistent, productive, and strong-willed. These traits loaded on two correlated factors (explaining 56.3% of the variance), one capturing high activity and energy component, and the second capturing a motivation and drive component.

#### Traits distinguished by cluster.

A second set of analyses started with the activity clusters and examined which traits best distinguish the groups. Using *t*-tests, the 38 traits were tested for significant differences between the active (cluster 3) and inactive (cluster 1) groups. The groups were most strongly differentiated by nine positive traits (active, athletic, energetic, involved, preserving, persistent, self-disciplined, self-reliant, and socially confident) and five negative traits (fearful, fretful, jealous, lazy, and lethargic). Weaker (but still significant) relations were also found for diligent, emotionally stable, good-looking, perceptive, strong-willed, fidgety, moody, rude, shy, sloppy, self-centered, tense, and unattractive.

#### Combining Rational and Empirical Analyses

Results from the factor-based analysis and the cluster-based analysis were then combined. Thirteen traits were consistently identified (that is, the raters had identified the traits as describing an active or inactive person, the traits grouped together in the data, and active individuals were more likely to exhibit these traits).<sup>18</sup> The sample was randomly divided and a final factor analysis was performed in the first half and confirmed in the second. In the first half, the factor analysis suggested two factors, accounting for 89% of the variance. Essentially, there was a positive component (identified by 9 active-type traits;  $\alpha = 0.87$ ) and a negative component (identifying by 4 inactive-type traits;  $\alpha = 0.65$ ). Repeating the analysis in the second group indicated a similar structure, with two factors accounting for 88.5% of the variance. Again, there was a positive component (9 traits,  $\alpha = 0.87$ ) and a negative component (4 traits,  $\alpha = 0.63$ ; “tense” did not load well on either factor). To create the final construct, the negative traits were excluded to leave a more parsimonious unidimensional construct. The 9 remaining traits (active, athletic, energetic, self-disciplined, strong-willed, persevering, involved, persistent, and diligent) were summed to create a composite active personality scale ( $\alpha = 0.86$ ).

Average active personality scores were then compared across the clusters. As expected, clusters differed significantly on this variable ( $F(2,281) = 16.25, p < .0001$ ), and the variable followed the expected pattern (lowest levels in cluster 1, highest levels in cluster 3;  $t(278) = 5.30, p < .0001, r = 0.30$ ). Thus, the composite active personality variable successfully distinguished between active and inactive individuals.

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<sup>18</sup> Traits included 9 positive traits (describing activity): active, athletic, energetic, self-disciplined, strong-willed, persevering, involved, persistent, and diligent; and 4 negative traits (describing inactivity): lethargic, lazy, tense, and fearful.

The active personality variable was correlated with the other individual, social, and health-related variables. As summarized in [Table 15](#), a more active personality strongly correlated not only with actually being more physically active, but also with better self-rated health and well-being, fewer perceived barriers and more perceived benefits to being active, and better social relationships. There were no differences between males and females.

### **Part 3: Predicting physical activity and health**

Third, a model linking active personality traits, individual characteristics, personal history, and social factors with physical activity and health was tested using regression, path, and SEM analyses.

Path relations were first tested using linear regression in SAS. [Table 16](#) summarizes the results of these models. Both individual aspects and social support were important predictors, but there was not a significant interaction between personality and social support. Across the models, the active personality variable was the strongest predictor. The final model included sex, active personality, perceived barriers, social support for activity, and childhood activity, and accounted for 32% of the variance in physical activity. This is comparable to other studies. A model predicting physical health from physical activity, controlling for the other variables, was then evaluated. Physical activity, active personality, and perceived barriers were significant predictors of health; together, these variables explained 40% of the variance in physical health. The other individual and social variables were not significant.

Path and SEM models were then evaluated. For parsimony, only the significant variables from the final regression analyses (active personality, child activity, perceived barriers, sex, social support to be active, physical health) were included. The path model for the composite variables, physical activity, and health replicated the regression results found in SAS. Next, the full path model was estimated. All paths were significant, and the model fit the data ( $RMSEA = 0.02$  [95%  $CI = 0.00, 0.10$ ]). The SEM model was then evaluated, in which the active personality, physical activity, and physical health were defined as latent variables. Results are displayed in [Figure 7](#). The model did not fit the data ( $RMSEA = 0.10$  [95%  $CI = 0.09, 0.11$ ]). As this was a preliminary consideration of the SEM model, further refinement was not pursued. Future studies will examine the model more and evaluate possible changes that would better capture the data.

#### **Part 4: Validating the Terman activity variable**

Finally, a set of variables assessed in both the Terman and PHAB samples were examined to validate the Terman activity measure and to directly examine comparable personality, activity, and health relations across the two samples. In the PHAB sample, correlations for the various individual, social, and health variables were compared between the composite physical activity variable and the single physical activity item from the Terman study (i.e., activity level based on leisure time activity reports), and between the active personality composite and the sub-set of trait assessed in the Terman sample. [Table 17](#) summarizes relations for the physical activity and active personality variables. For both physical activity and personality, relations were weaker for the less reliable Terman items, but all relations were in the same direction, and many of the relations remained significant. This suggests that any relations between physical

activity, personality, and health that are found in the Terman data most likely underestimate actual effects.

The comparable items were then examined in the Terman sample. [Table 18](#) summarizes relations of the 1940 and 1950 activity variables and active personality variables (child and adult) with the other variables. Most of the relations found in the PHAB study were replicated in the Terman sample. Cross-sectional relations (i.e., 1940 activity with variables assessed in 1940 and 1950 activity with variables assessed in 1950) were stronger than cross-time relations. Not surprisingly, relations were stronger for the adult active personality variable than for the child active personality variable. The adult variable was measured more contemporaneously (i.e., the adult active personality traits were self-reported in 1940, and the correlated variables were self-reported in 1940 or 1950), and with a similar method (self-report versus parent-teacher ratings for child personality). Active traits were related to sex in the Terman sample (men were more likely to possess these traits), but were not related to sex in the PHAB sample. In addition, the drive for success variable was related to physical activity in the Terman sample, but not in the PHAB sample. Despite the lower reliability in the Terman items, the consistency between the two samples lends support to both the cross-sectional relations found in the PHAB sample (Study 2 in this project) and the cross-time relations found in the Terman sample (Study 1 in this project).

### **Study 2 Summary of Findings**

The second study aimed to empirically determine a set of personality traits that distinguish active and inactive individuals, test a basic model predicting physical activity

and health from both individual and social factors, and help validate the activity measure from the Terman sample.

Through a combination of rational and empirical assessment, a set of traits was identified that theoretically and empirically distinguished active and inactive individuals. The traits themselves mostly capture the achievement-oriented component of conscientiousness and the activity component of extraversion. A more active personality strongly correlated with better self-rated health and well-being, fewer perceived barriers and more perceived benefits to being active, and better social relationships. There were no differences between males and females. In regression analyses, both individual aspects and social support were important predictors of physical activity and health, and there was no interaction between personality and social support. Physical activity was predicted by the active personality trait, sex, perceived barriers, social support for activity, and childhood activity. Physical health was predicted by physical activity, the active personality variable, and perceived barriers.

A set of variables, measured in both the PHAB and Terman studies, was tested for comparable relations across the short term (in the PHAB study) and long term (in the Terman sample). Most of the relations found in the PHAB study were replicated in the Terman sample, although cross-sectional relations were stronger than cross-time relations. The comparisons suggest that findings in the Terman sample do generalize beyond the specific sample, and most likely underestimate actual effects due to low reliability.

## **GENERAL DISCUSSION**

In epidemiological research, inactivity and obesity have clearly been linked to poor health outcomes, including early mortality. Yet two contradictory trends are evident in modern U.S. culture. At the same time, the obesity epidemic is driving individual- and societal-level concerns about over-eating and lack of exercise. Spoken norms criticize overeating and stress the need for gym memberships, fad diets, and quick fixes. On the other hand, lifestyles have become increasingly sedentary and eating habits are driven by the consumption of massive quantities of unhealthy foods.

This project focused on the physical activity element of a healthy lifestyle. Although the study of individual differences in fitness and activity has a long history in psychology, the issue has been neglected until relatively recently. Recent developments in public health highlight the importance of understanding individual variations in health-relevant behaviors. The first study recast an archival sample to examine average patterns of physical activity, personality predictors of individual variation in these patterns across many decades, and lifespan health and longevity outcomes. The second study examined specific personality traits related to more or less activity and health outcomes, the interaction with social factors, and supported the validity of the activity variables in the Terman data.

### **Growth Patterns and Individual Variation**

Using archival data that followed individuals from childhood in 1922 through death, physical activity related to health across the lifespan, but not in a straightforward manner. For the sample as a whole, there was a general pattern of decelerating decline with age. Both qualitatively and quantitatively, however, there were substantial intra-

and inter-individual variation in the types and intensity of activities reported, with some people decreasing, some maintaining, and some increasing their activity over the years (see [Figure 2](#)). For example, at age 57, one participant wrote “leader - service club, river trips, raft & canoe, kayaking”, whereas another participant wrote “only sleep, food, and drink have been important. Nothing else makes an impression one way or the other”. Importantly, personality factors assessed concurrently and much earlier in life predicted both the level of activity and change.

Using cross-sectional data from two large surveys, Caspersen and colleagues (2000) examined sex and age-related patterns of physical activity across the lifespan. They found that over time inactivity increased, moderate activity remained fairly stable with some decline, and vigorous activity declined from adolescence, through early and middle adulthood, and into older age. Although informative, the findings were limited by the cross-sectional nature of the data. Importantly, results from the Terman sample supported these cross-sectional patterns. There was a general pattern of decline across age, although the decline was relatively small (decreasing less than one MET). That the growth results reflect the patterns that would be predicted based on cross-sectional and short-term longitudinal studies lends credence both to the cross-sectional findings and to the validity of the Terman sample findings.

By using longitudinal data, variation in activity trajectories and individual predictors of this variation, measured prospectively, could be examined. As sex differences are typically found in physical activity research (e.g., Talbot, Fleg, & Metter, 2003), males and females were examined separately. Males were more active than females across the five measurement occasions. Although a quadratic model was

optimal for both sexes, females demonstrated less variance than males. Women may face more barriers for exercise, both in terms of sociocultural norms (e.g., in the 1940-60 period, it was more acceptable for men to engage in sports and active pastimes) and in terms of family responsibilities.

Personality predictors were stronger for males, whereas health variables were stronger for females. Specifically, for males, child energy, sociability, and interest in active pastimes (child report), and adult neuroticism and extraversion predicted level and slope, and birth weight, child activity (parent report), BMI, self-rated health, mental adjustment, and social ties predicted the level effect. For females, adult health and mental adjustment predicted the level and slope, and child energy, sociability, activity (child and parent report), and puberty predicted the level effect. Future studies should continue to examine sex differences in activity levels and change, especially within the social context of implicit and explicit gender-related norms.

Meaningful variation could be explained by personality characteristics. In particular, child energy and sociability, and adult extraversion and neuroticism predicted different levels and patterns of activity, even after controlling for key psychosocial and health-related variables. Tracking studies (by others) across shorter periods – one or two decades – have suggested that early activity, levels of energy and social experiences with sports are among the strongest predictors of later activity (Barnekow-Bergkvist, Hedberg, Janlert, & Jansson, 1998; Glenmark, Hedberg, & Jansson, 1994; Tammelin, 2005; Telama, Yang, Laakso, & Vikari, 1997). These findings support this, now over a longer period from childhood through adulthood. Higher levels of childhood energy and sociability, rated by parents and teachers in 1922, predicted higher levels of

activity at age 29 for both males and females. The energy variable reflects Thomas and Chess's (1977) active temperament and the activity facet of extraversion. The sociability trait reflects the social facet of extraversion (including items such as "fondness of large groups" and "preference for social activities at parties"), suggesting a social pathway linking early personality and physical activity. Early characteristics may pull individuals toward environments that are supportive of an active lifestyle (Friedman, 2000). Future research should consider how such characteristics unfold within different social environments.

Other psychosocial characteristics, including birth weight for males, pubertal age for females, and health and well-being for both, were also relevant to activity patterns. Individual differences across physical and mental domains should be considered when designing interventions. For example, early health factors may impact a person's initial tendency to be active or inactive. Some individuals tolerate activity well, whereas others are naturally more prone to injury and will opt for more sedentary pastimes (Ekkekakis et al., 2005). Importantly, including these physical and mental variables did not alter the personality-activity links.

### **Lifespan health and longevity outcomes**

From a public health perspective, physical activity trajectories matter to the extent that differences relate to health and well-being outcomes. Current federal guidelines suggest that males and females of all ages, including those with chronic conditions (under doctor supervision) can benefit from including moderate or vigorous physical activity in their lives (USDHHS, 2008). Although physical activity is associated

with better health, the extent to which these relations reflect achieving certain levels of activity versus living an active lifestyle in general is unclear. Study 1 investigated lifespan health outcomes associated with activity levels at different ages and changes in activity as people age.

Although activity levels were associated with health outcomes cross-sectionally and across shorter time periods, they were less associated with health across longer periods. Early activity levels (childhood and early adulthood), although relevant to midlife and older age physical health and subjective well-being, were not related to mortality risk, whereas later activity levels (in middle age) predicted lower mortality risk. Health benefits may arise by maintaining an active lifestyle, rather than having specific periods of high activity. Supplemental analyses that compared groups of high, low, increasing, and decreasing activity offer additional support; individuals who were more active (i.e., their individual level of activity was above the mean at baseline) or increased in activity (i.e., their individual slope was positive) lived longer (on average) than those who were inactive or decreased activity.

In one of the first studies linking physical activity and mortality risk (Paffenbarger et al., 1993; 1994), higher levels of activity predicted lower risk, but only for those who continued to be active. Athletes who were active early on but became sedentary after college were at a higher mortality risk than nonathletes and athletes who remained active. Evidence is building that retired athletes who become sedentary are at an especially increased risk of health problems (Witkowski & Spangenburg, 2008). In a recent study of Swedish men (Byberg et al., 2009), high physical activity, when maintained from age 50 to 60, was protective from mortality risk; compared to

individuals who were inactive or decreased activity. For those who increased activity, mortality risk increased in the first five years, and then decreased, such that after 10 years, they had a similar protective risk to those who were continuously active. Early activity may be important to the extent that habits are formed and active lifestyles are created, but most likely it is the continued activity that provides true health benefits.

For intervention research, the results support the optimistic conception that if people can successfully initiate and maintain an active lifestyle, health benefits accrue and life potentially can be extended. Although causation cannot be determined with these types of data and analyses, the results support a growing literature that suggests a causal impact of physical activity on health (USDHHS, 2008). Active individuals were more likely to be healthy at midlife and in older age, even after controlling for baseline health. Later age health and longevity can arguably be considered end points in a causal chain (that is, late life health cannot cause activity forty years prior). Further, there was some indication of a dose-response-- continued activity related to positive outcomes, whereas declines in activity related to negative outcomes. To some extent health, well-being, and physical activity influence one another, but as a whole, the results demonstrate the benefit of staying physically active and involved in life.

Notably, levels of physical activity were not extreme-- benefit was evident for moderately low levels of activity. Further, the number of activities was a predictor of later life social competence, productivity, and mortality risk, suggesting that part of the benefit comes from active involvement in life. A physically active lifestyle may be a marker of a healthy trajectory. The challenge remains in how to motivate such lifestyles. Health and behavior trajectories matter, and are influenced by prior experiences and

basic personality differences (see also Friedman et al., 2008). Short bouts of activity may do little to improve health and lengthen life.

### **Personality, activity, and health**

By identifying traits that predict activity, interventions can be designed that better fit a person's natural inclinations to engage in or to avoid physical activity. For example, it may be easier for an individual who is naturally energetic and driven to maintain an active lifestyle, if that energy and drive is channeled toward an active lifestyle. Conversely, a neurotic, lethargic individual, may temporarily follow an exercise program, but without additional support, resort to a sedentary lifestyle. The second part of this project identified a set of traits that distinguished active and inactive individuals, and cross-sectionally related personality and activity to health outcomes.

Nine traits were identified that rationally and empirically distinguished active and inactive individuals: active, athletic, energetic, self-disciplined, strong-willed, persevering, involved, persistent, and diligent. The traits capture the achievement-oriented component of conscientiousness and the activity component of extraversion. Predictions over and above the Big Five factors could not be examined, as the composite active personality variable included persistence and self-discipline from the conscientiousness facet and energy and activity from the extraversion facet. However, some research literature suggests that it may be the cross between traits rather than the broad five factors that is most important in predicting behavior. For example, in a cross-sectional study with university students, the facet level traits of self-discipline (from

conscientiousness) and activity (from extraversion) independently predicted exercise behavior (Hoyt, Rhodes, Hausenblas, & Giacobbi, 2009).

In regression analyses, the composite active personality factor, child activity, perceived barriers, and social support for activity predicted engaging in more active pastimes. These cross-sectional relations support a multi-modal perspective, in which a person's history, personality, cognitive perceptions, and social relationships, both past and present, together impact health-related behavior and associated health outcomes.

### **Cross-study comparison**

A conceptual strength of the study was the ability to use equivalent items in the Terman and PHAB studies to directly compare personality, activity, and health relations, adding validity to the findings from each study. Across the two studies, physical activity related to better health outcomes, including higher self-rated health, subjective well-being, and increased levels of energy. These relations were stronger in cross-sectional and short-term correlations than across the lifespan. Again, this suggests that although activity relates to short-term benefits, it may be the continued pattern of active living that is important for long-term health benefits. From a lifespan perspective, cross-sectional findings are a snapshot of a person's trajectory. To the extent that an individual maintains his or her trajectory, personality, health, and activity will relate in a similar manner, and should be comparable across multiple studies.

It is clear that personality matters to health and is an important factor to consider in understanding activity patterns as people age. In both samples, personality related to both physical activity and health. In the Terman sample, adult personality predicted both

levels and changes in activity, especially for males. Similarly, in the PHAB study, high extraversion and low neuroticism predicted higher levels of activity. Prior studies suggest that active individuals are more extraverted, less neurotic, and more conscientious (Rhodes & Smith, 2006). The results of both studies confirmed that lower neuroticism and higher extraversion were independently related to higher levels of activity. Conscientiousness was not related to physical activity in the Terman sample, and was only marginally related to activity in the PHAB sample. Conscientiousness has been linked to better health outcomes, including lower mortality risk (Kern & Friedman, 2008), but this is not necessarily through health behaviors like physical activity (Bogg & Roberts, 2004; Friedman et al., 1995). Alternatively, trait-level analyses and combinations of lower order traits (in this case, activity and energy from extraversion and self-discipline and drive from conscientiousness) may be more predictive of both levels and changes in activity (Cloninger, 2005; Rhodes et al., 2002). For example, when the self-discipline and drive component of the conscientiousness factor were considered as part of an active personality, the traits did predict higher levels of physical activity.

Social relationships may act as moderators of activity-health trajectories. There were some hints of this within the two studies, although results were inconclusive. The lack of interactive effects most likely is due to measurement error. In the PHAB sample, individuals with more social support for activity were more active, and active personality traits related to better relationship quality. Supplemental analyses in the Terman data pointed toward social ties as an element distinguishing active, long-lived individuals with inactive, short-lived individuals for males. Active individuals may be more adept at

building social relationships, which in turn can buffer stress and negative events (Reblin & Uchino, 2008; Taylor, 2007; Uchino, Cacioppo, & Kiecolt-Glaser, 1996). Social relationships should be further considered within life course trajectories of behavior and health.

Trajectories are important, and personality influences the trajectory a person follows. Future studies should identify elements that throw individuals off a healthy active trajectory, pushing inactive individuals toward health, or active individuals toward illness. Taking this a step further, this project focused on the trait level to identify a set of traits that distinguish active and inactive individuals. In both samples, this set of traits related to better health and life satisfaction and higher levels of physical activity. Notably, in the Terman sample, the child version of these traits related to better self-rated health in 1940, and the adult version related to better self-rated health at midlife. In the PHAB sample, the composite personality variable also related to better social ties, and predicted both physical activity and health in regression analyses. The next step would be to use this information to inform an intervention, and consider specific interactions with social support and stressful events, to test specific theoretical models that include multi-level psychosocial components.

## **Limitations**

### Study 1: The Terman Sample

With a longitudinal study of a single cohort, care should be taken in generalizing results to other groups, time periods, and places. The Terman sample was mostly European-American and from a middle class background. While this homogeneity

presents some limitations, it also presents some important benefits. Comparisons can be made within the group without being confounded by characteristics such as lack of access to or understanding of health care; further, the participants had access to a wide range of leisure time physical activities. Although the sample is highly intelligent, studies with this sample have shown a large degree of psychosocial variability (Friedman, et al., 1995; Schwartz et al., 1995; Tucker et al., 1997), and prior findings in this sample on personality and health and longevity have been confirmed in follow-up studies by others, including meta-analyses and representative national samples (Goodwin & Friedman, 2006; Kern & Friedman, 2008; Martin, Friedman & Schwartz, 2007). Further, analyses examining the effect of selection based on IQ and total years of education have shown minimal effects on health, well-being, and physical activity variables (Reynolds et al., 2007). Notably, the sample is more representative than many well-known longitudinal studies of doctors, nurses, or heart disease patients.

As is the case with any longitudinal study, it is possible or even likely that cohort effects play a role. For example, an active lifestyle for women of this generation may have involved staying at home and caring for the family, whereas for men it may have included more sports-related activities. Federally recommended guidelines on activity were nonexistent. The sample as a whole was relatively inactive, averaging between 2.5 and 3.3 METs across the years (3 to 6 METs are considered moderate activity). Care should be taken in generalizing the results. Nevertheless, the results fit well with and extend other cross-sectional and shorter-term studies.

The study was also limited by the use of a relatively simple measure of physical activity (i.e., a single free-response question on leisure time activities). Although values

were converted to MET values and the results are consistent with the general parameters of previous studies (Caspersen et al., 2000; Sallis, 2000), it was impossible to assess actual frequency and intensity. As such, the activity measure reflects an active lifestyle to a greater extent than a specific level of activity. Interestingly, the number of activities reported each year was a stronger predictor of survival and older age health (especially social competence and productivity) than activity levels. The number of activities may reflect a protective effect of active involvement with society. Measuring physical activity is challenging, and there is no gold standard measurement (Treuth, 2002; Welk, 2002). Studies should continue to examine long-term patterns, especially individual variation in these patterns, with other samples and other methods of measuring physical activity.

Although the analyses considered correlates and antecedents of physical activity, it is important to note that growth curve analyses cannot determine causal relations between the variables. It is likely that personality, social factors, health behaviors such as physical activity, and health-related variables influence one another in a complex web of multi-directional relations.

### Study 2: The PHAB sample

The second study was limited by the questions included on the measure. The questions focused on physical activity and personality, but should have included better measures of key constructs identified in the literature, such as self-efficacy, intentions to exercise, and social relationships. Although regression analyses linked personality, social support, barriers, history, physical activity, and health, the SEM model did not achieve optimal fit, and problems were due to the measurement portion of the model. In

addition, some participants, especially community-member participants, did not complete the entire survey, due to length or computer problems. A shorter, focused survey would be helpful for capturing a more representative portion of the population.

The study was also limited by the cross-sectional nature of the study. Child activity predicted current levels of activity, but these were based on retrospective reports and are subject to bias. Additionally, as is commonly done in psychological research, over half of the sample was young college students. Still, although less relevant to lifelong health outcomes, activities done in early adulthood may set healthy or unhealthy patterns that will be pursued for years to come, in which case college students may be an ideal group for interventions that establish healthy lifestyles and prevent chronic health problems from developing. The similar pattern of results across both the Terman and PHAB samples supports the validity in each study, but it is impossible to study processes over time with cross-sectional data.

## **Conclusion**

Overall, the studies suggest that patterns of activity over time are important, that individuals vary significantly in the trajectories they display, and that various psychosocial factors influence these trajectories. Future studies might examine whether the level of activity, the change in activity, or the combination of the two is most relevant for important health and well-being outcomes across long time periods, consider the extent to which personality factors contribute, and investigate systematically how personality unfolds within different social contexts to impact activity patterns and health outcomes across the lifespan.

At a broader level, the results are informative for intervention research. Activity trajectories are influenced by individual differences and social factors. Optimal interventions for both initiating and maintaining activity necessarily must consider the individual's history, predispositions, and psychosocial environment. Trajectories of past physical activity will inform current activities. This project offers support for the idea that health outcomes are related to physical activity trajectories, but this depends on the fit between the person and subsequent experiences. Altogether, it is not sufficient to know where a person is at; understanding individual trajectories within the context of personality, past experiences, and current situations is imperative.

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**Table 1***Terman sample: Basic descriptive statistics*

| Variable                                       | N    | Mean   | SD    | Min    | Max    |
|--|------|--------|-------|--------|--------|
| <b>Main Variables</b>                          |      |        |       |        |        |
| Sex  | 1409 | 0.43   | 0.50  | 0.00   | 1.00   |
| Age, 1936                                      | 1409 | 25.02  | 3.65  | 10.71  | 35.57  |
| Physical activity, 1936                        | 1079 | 3.18   | 1.56  | 1.00   | 12.00  |
| Physical activity, 1940                        | 1084 | 3.29   | 1.34  | 1.00   | 8.33   |
| Physical activity, 1950                        | 1173 | 3.10   | 1.10  | 1.00   | 10.30  |
| Physical activity, 1960                        | 1104 | 2.94   | 1.00  | 0.90   | 9.00   |
| Physical activity, 1972                        | 845  | 2.53   | 0.95  | 0.90   | 12.00  |
| <b>Childhood Variables (1922 assessment)</b>   |      |        |       |        |        |
| IQ   | 1409 | 148.75 | 10.31 | 135.00 | 201.00 |
| SES  | 1114 | 7.38   | 3.16  | 0.01   | 12.97  |
| Birth weight                                   | 1215 | 8.35   | 1.50  | 4.00   | 13.00  |
| Infant health                                  | 1229 | 3.30   | 0.82  | 1.00   | 4.00   |
| Age of puberty                                 | 1040 | 13.38  | 1.44  | 10.00  | 17.00  |
| Interest in active pastimes (child report)     | 1310 | 3.48   | 0.85  | 1.00   | 4.00   |
| Activity (parent report)                       | 1243 | 6.98   | 4.03  | 0.00   | 18.00  |
| Personality: conscientiousness                 | 1325 | 21.01  | 4.82  | 4.00   | 34.00  |
| Personality: cheerfulness                      | 1325 | 20.94  | 2.56  | 12.00  | 28.00  |
| Personality: sociability                       | 1325 | 21.02  | 4.14  | 5.00   | 34.00  |
| Personality: energy                            | 1325 | 21.03  | 2.35  | 10.00  | 32.00  |
| Personality: motivation                        | 1325 | 20.98  | 5.17  | 5.00   | 36.00  |
| Personality: permanency of moods               | 1325 | 21.02  | 1.50  | 16.00  | 25.00  |
| <b>Early Adult Variables (1940 Assessment)</b> |      |        |       |        |        |
| Body mass index                                | 1220 | 22.04  | 2.73  | 11.86  | 39.86  |
| Self-rated health:                             | 1230 | 3.35   | 0.75  | 1.00   | 4.00   |
| Mental adjustment (staff rating)               | 1337 | 2.77   | 0.50  | 1.00   | 3.00   |
| Alcohol use (self report)                      | 1227 | 1.49   | 0.52  | 1.00   | 3.00   |
| Social ties                                    | 1283 | 4.23   | 2.47  | 0.00   | 12.00  |
| Personality: conscientiousness                 | 1214 | 10.01  | 0.63  | 8.07   | 11.68  |
| Personality: agreeableness                     | 1214 | 10.00  | 0.57  | 8.31   | 11.17  |
| Personality: extraversion                      | 1214 | 10.00  | 0.64  | 8.39   | 11.61  |
| Personality: neuroticism                       | 1214 | 10.00  | 0.60  | 8.76   | 11.89  |
| <b>Midlife Variables</b>                       |      |        |       |        |        |
| Self-rate health, 1950-60                      | 1303 | 3.24   | 0.70  | 1.00   | 4.00   |
| Mental adjustment, 1950-60                     | 1302 | 2.58   | 0.64  | 1.00   | 3.00   |
| Alcohol use, 1950-60                           | 1302 | 1.90   | 0.53  | 1.00   | 3.00   |

| <b>Variable</b>                              | <b>N</b> | <b>Mean</b> | <b>SD</b> | <b>Min</b> | <b>Max</b> |
|--|----------|-------------|-----------|------------|------------|
| Stressful life events, 1950                  | 1266     | 1.31        | 1.01      | 0.00       | 3.00       |
| Lifelong education attainment                | 1409     | 16.50       | 2.71      | 10.00      | 22.00      |
| Social ties, 1950-60                         | 1303     | 6.71        | 2.76      | 0.00       | 13.00      |
| <b>Old Age Health (1986) &amp; Longevity</b> |          |             |           |            |            |
| Healthy aging: physical health               | 715      | 3.00        | 0.92      | 0.67       | 4.94       |
| Healthy aging: subjective well-being         | 715      | 3.00        | 0.70      | 1.31       | 5.67       |
| Healthy aging: social competence             | 715      | 3.00        | 0.80      | 1.05       | 4.79       |
| Healthy aging: productivity                  | 715      | 3.00        | 0.86      | 1.00       | 5.11       |
| Age at death <sup>a</sup>                    | 1258     | 80.53       | 14.86     | 20.77      | 102.71     |

<sup>a</sup> Median age of death, using the Kaplan-Meier estimate

**Table 2**

*Terman sample: Correlations between the five physical activity variables and other variables*

|  | 1936 Activity   | 1940 activity   | 1950 activity   | 1960 activity   | 1972 activity  |
|--|-----------------|-----------------|-----------------|-----------------|----------------|
| Sex  | -0.15 (1079)*** | -0.14 (1084)*** | -0.20 (1173)*** | -0.21 (1104)*** | -0.20 (845)*** |
| Age 1936                                       | -0.05 (1079)    | -0.00 (1084)    | -0.03 (1173)    | -0.09 (1104)**  | -0.06 (845)    |
| Males  | -0.03 (618)     | 0.01 (617)      | 0.01 (617)      | -0.10 (602)*    | -0.06 (446)**  |
| Females  | -0.15 (461)**   | -0.06 (467)     | -0.09 (507)     | -0.13 (502)**   | -0.14 (499)**  |
| <b>Physical Activity Variables<sup>a</sup></b> |                 |                 |                 |                 |                |
| 1936 activity                                  | 1.00 (1079)     | 0.50 (533)      | 0.31 (533)**    | 0.22 (533)**    | 0.16 (533)**   |
| Males  | 1.00 (618)      | 0.51 (282)***   | 0.33 (282)***   | 0.20 (282)***   | 0.13 (282)*    |
| Females  | 1.00 (461)      | 0.42 (251)**    | 0.18 (251)*     | 0.18 (251)**    | 0.14 (251)**   |
| 1940 activity                                  | 0.44 (882)**    | 1.00 (1084)     | 0.36 (533)**    | 0.29 (533)**    | 0.13 (533)**   |
| Males  | 0.43 (506)**    | 1.00 (617)      | 0.34 (282)***   | 0.23 (282)***   | 0.06 (282)     |
| Females  | 0.43 (376)**    | 1.00 (467)      | 0.32 (251)**    | 0.31 (251)**    | 0.24 (251)**   |
| 1950 activity                                  | 0.32 (920)**    | 0.39 (948)**    | 1.00 (1173)     | 0.44 (533)**    | 0.25 (533)**   |
| Males  | 0.34 (527)**    | 0.37 (542)**    | 1.00 (666)      | 0.42 (282)***   | 0.20 (282)**   |
| Females  | 0.22 (393)**    | 0.35 (406)**    | 1.00 (507)      | 0.40 (251)**    | 0.24 (251)**   |
| 1960 activity                                  | 0.24 (869)**    | 0.30 (895)**    | 0.47 (1001)**   | 1.00 (1104)     | 0.29 (533)**   |
| Males  | 0.24 (478)**    | 0.26 (491)**    | 0.48 (547)**    | 1.00 (602)      | 0.24 (282)**   |
| Females  | 0.17 (391)**    | 0.31 (404)**    | 0.36 (454)**    | 1.00 (502)      | 0.31 (251)**   |
| 1972 activity                                  | 0.15 (671)*     | 0.20 (695)**    | 0.26 (763)**    | 0.33 (782)**    | 1.00 (845)     |
| Males  | 0.14 (348)*     | 0.18 (370)**    | 0.23 (405)**    | 0.32 (412)**    | 1.00 (446)     |
| Females  | 0.08 (323)      | 0.15 (325)**    | 0.21 (358)**    | 0.25 (370)**    | 1.00 (399)     |
| <b>Child variables (1922 assessment)</b>       |                 |                 |                 |                 |                |
| IQ   | -0.03 (1079)    | -0.01 (1084)    | -0.02 (1173)    | -0.00 (1104)    | -0.01 (845)    |
| Males  | -0.08 (618)     | -0.05 (617)     | -0.05 (666)     | -0.01 (602)     | -0.01 (446)    |
| Females  | 0.04 (461)      | 0.03 (467)      | 0.03 (507)      | -0.10 (502)     | -0.01 (399)    |
| SES  | 0.00 (861)      | -0.02 (851)     | -0.00 (928)     | 0.01 (877)      | 0.01 (670)     |
| Males  | -0.02 (433)     | -0.10 (428)*    | -0.02 (464)     | -0.03 (419)     | -0.01 (306)    |
| Females  | 0.05 (428)      | 0.09 (423)      | 0.05 (464)      | 0.08 (458)      | 0.06 (364)     |
| Birth weigh                                    | 0.03 (951)      | 0.11 (932)**    | 0.10 (1008)**   | 0.09 (952)**    | 0.08 (731)*    |
| Males  | 0.03 (542)      | 0.10 (528)*     | 0.10 (570)      | 0.07 (519)      | 0.07 (389)     |
| Females t                                      | -0.02 (409)     | 0.09 (404)      | 0.03 (438)      | 0.02 (433)      | 0.00 (342)     |
| Infant health                                  | -0.07 (967)     | 0.00 (943)      | -0.01 (1016)    | 0.06 (962)      | -0.04 (737)    |
| Males  | -0.07 (546)     | 0.00 (531)      | -0.01 (572)     | 0.06 (518)      | -0.06 (388)    |
| Females  | -0.08 (421)     | 0.01 (412)      | -0.03 (444)     | 0.05 (444)      | 0.00 (349)     |
| Puberty  | 0.07 (831)*     | 0.13 (811)**    | 0.13 (865)**    | 0.16 (825)**    | 0.14 (625)**   |
| Males  | -0.03 (407)     | 0.04 (387)*     | 0.01 (408)      | 0.02 (371)      | 0.03 (274)     |
| Females  | 0.01 (424)      | 0.11 (424)**    | 0.03 (457)**    | 0.10 (454)**    | 0.01 (355)     |
| Child interest                                 | 0.08 (1017)**   | 0.10 (1011)**   | 0.11 (1091)**   | 0.10 (1032)**   | 0.04 (788)     |
| Males  | 0.11 (577)**    | 0.08 (571)*     | 0.16 (612)***   | 0.09 (559)*     | 0.02 (412)     |
| Females  | 0.04 (440)      | 0.12 (440)*     | 0.03 (479)      | 0.10 (454)*     | 0.06 (376)     |
| Active child                                   | 0.06 (972)      | 0.05 (962)      | -0.01 (1033)    | -0.00 (973)     | -0.03 (746)    |
| Males  | 0.06 (556)      | 0.07 (549)      | 0.02 (589)      | 0.01 (533)      | 0.01 (397)     |
| Females  | 0.12 (416)*     | 0.06 (413)      | 0.05 (444)      | 0.09 (440)      | 0.02 (349)     |
| Conscien                                       | -0.02 (1037)    | 0.01 (1016)     | -0.01 (1099)    | -0.07 (1035)*   | -0.03 (792)    |
| Males  | 0.03 (595)      | 0.06 (577)      | -0.03 (623)     | -0.08 (563)*    | -0.01 (417)    |
| Females  | -0.07 (442)     | -0.03 (439)     | 0.08 (476)      | 0.01 (472)      | -0.02 (375)    |
| Cheerfulness                                   | -0.00 (1037)    | 0.05 (1016)     | 0.05 (1099)     | -0.04 (1035)    | -0.01 (792)    |
| Males  | -0.01 (595)     | 0.03 (577)      | 0.05 (623)      | -0.07 (563)     | -0.07 (417)*   |
| Females  | 0.01 (442)      | 0.07 (439)      | 0.04 (476)      | 0.01 (472)      | 0.11 (375)     |

|             | 1936 Activity             | 1940 activity              | 1950 activity             | 1960 activity             | 1972 activity           |
|-------------|---------------------------|----------------------------|---------------------------|---------------------------|-------------------------|
| Sociability | 0.06 (1037)               | 0.12 (1016) <sup>***</sup> | 0.06 (1099) <sup>*</sup>  | 0.03 (1035)               | 0.01 (792)              |
| Males       | 0.13 (595) <sup>**</sup>  | 0.16 (577) <sup>***</sup>  | 0.14 (623)                | 0.07 (563)                | 0.03 (417)              |
| Females     | 0.02 (442)                | 0.14 (439) <sup>***</sup>  | 0.03 (476)                | 0.06 (472) <sup>**</sup>  | 0.09 (375)              |
| Energy      | 0.09 (1037) <sup>**</sup> | 0.14 (1016) <sup>***</sup> | 0.10 (1099) <sup>**</sup> | 0.09 (1035)               | 0.07 (792) <sup>*</sup> |
| Males       | 0.11 (595) <sup>**</sup>  | 0.17 (577) <sup>***</sup>  | 0.16 (623) <sup>***</sup> | 0.07 (563)                | 0.09 (417)              |
| Females     | 0.09 (442)                | 0.11 (439) <sup>*</sup>    | 0.04 (476)                | 0.15 (472) <sup>***</sup> | 0.09 (375)              |
| Motivation  | -0.04 (1037)              | 0.03 (1016)                | -0.04 (1099)              | -0.02 (1035)              | -0.04 (792)             |
| Males       | -0.03 (595)               | 0.04 (577)                 | -0.03 (623)               | -0.05 (563)               | -0.01 (417)             |
| Females     | -0.05 (442)               | 0.02 (439)                 | -0.04 (476)               | 0.06 (472)                | -0.08 (375)             |
| Mood Perm   | 0.01 (1037)               | 0.03 (1016)                | 0.05 (1099)               | -0.04 (1035)              | 0.01 (792)              |
| Males       | 0.02 (595)                | 0.03 (577)                 | 0.05 (623)                | -0.06 (563)               | -0.03 (417)             |
| Females     | -0.04 (442)               | 0.02 (439)                 | 0.02 (476)                | -0.06 (472)               | 0.02 (375)              |

#### Early Adult Variables (1940 assessment)

|                 |                            |                            |                             |                            |             |
|-----------------|----------------------------|----------------------------|-----------------------------|----------------------------|-------------|
| BMI             | 0.07 (959) <sup>*</sup>    | 0.10 (1066) <sup>***</sup> | 0.05 (1048)                 | 0.06 (995) <sup>*</sup>    | 0.06 (771)  |
| Males           | 0.09 (544) <sup>*</sup>    | 0.13 (607) <sup>**</sup>   | 0.03 (585)                  | 0.06 (535)                 | 0.02 (407)  |
| Females         | -0.05 (415)                | -0.02 (459)                | -0.08 (463)                 | -0.06 (460) <sup>***</sup> | -0.02 (364) |
| Physical health | 0.11 (969) <sup>***</sup>  | 0.14 (1074) <sup>**</sup>  | 0.15 (1058) <sup>***</sup>  | 0.14 (1004) <sup>*</sup>   | 0.03 (776)  |
| Males           | 0.03 (551)                 | 0.09 (612) <sup>*</sup>    | 0.17 (592) <sup>***</sup>   | 0.11 (539) <sup>*</sup>    | 0.02 (408)  |
| Females         | 0.20 (418) <sup>***</sup>  | 0.17 (462) <sup>**</sup>   | 0.08 (466)                  | 0.14 (465) <sup>**</sup>   | 0.02 (368)  |
| Adjustment      | 0.06 (1039)                | 0.06 (1081)                | 0.12 (1136) <sup>***</sup>  | 0.07 (1071) <sup>*</sup>   | 0.03 (820)  |
| Males           | 0.05 (593)                 | 0.04 (614)                 | 0.14 (641) <sup>***</sup>   | 0.10 (578) <sup>*</sup>    | 0.01 (430)  |
| Females         | 0.20 (418) <sup>***</sup>  | 0.17 (462) <sup>***</sup>  | 0.09 (466)                  | 0.05 (493) <sup>*</sup>    | 0.06 (390)  |
| Alcohol use     | 0.06 (968) <sup>*</sup>    | 0.08 (070) <sup>**</sup>   | 0.12 (1056) <sup>***</sup>  | 0.08 (1005)                | 0.06 (777)  |
| Males           | 0.06 (548)                 | 0.05 (611)                 | 0.09 (590) <sup>*</sup>     | 0.03 (541)                 | -0.00 (407) |
| Females         | -0.03 (420)                | 0.02 (459)                 | -0.00 (466)                 | -0.00 (464)                | -0.02 (370) |
| Social ties     | 0.04 (1003)                | 0.04 (1084)                | -0.03 (1102)                | -0.01 (1038)               | 0.01 (800)  |
| Males           | 0.11 (566) <sup>*</sup>    | 0.10 (617) <sup>**</sup>   | -0.00 (614)                 | 0.00 (556)                 | 0.01 (419)  |
| Females         | -0.06 (437)                | -0.05 (467)                | -0.07 (488)                 | -0.03 (482)                | 0.00 (381)  |
| Conscien        | 0.02 (955)                 | 0.04 (1012)                | 0.06 (1042)                 | 0.04 (984)                 | 0.02 (756)  |
| Males           | 0.02 (544)                 | 0.04 (581)                 | 0.06 (587)                  | -0.01 (532)                | -0.02 (400) |
| Females         | -0.01 (411)                | 0.01 (431)                 | 0.00 (455)                  | 0.06 (452)                 | 0.03 (356)  |
| Agreeableness   | -0.06 (955)                | -0.05 (1012)               | -0.04 (1042)                | -0.05 (984)                | -0.06 (756) |
| Males           | -0.03 (544)                | -0.03 (581)                | 0.02 (587)                  | -0.01 (532)                | -0.07 (400) |
| Females         | -0.02 (411)                | -0.00 (431)                | -0.04 (455)                 | -0.03 (452)                | 0.03 (356)  |
| Extraversion    | 0.07 (955) <sup>*</sup>    | 0.15 (1012) <sup>**</sup>  | 0.08 (1042) <sup>**</sup>   | 0.05 (984)                 | 0.01 (756)  |
| Males           | 0.09 (544) <sup>*</sup>    | 0.17 (581) <sup>***</sup>  | 0.13 (587) <sup>**</sup>    | 0.10 (532) <sup>*</sup>    | -0.00 (400) |
| Females         | 0.07 (411)                 | 0.14 (431) <sup>**</sup>   | 0.05 (455)                  | 0.02 (452)                 | 0.03 (356)  |
| Neuroticism     | -0.12 (955) <sup>***</sup> | -0.10 (1012) <sup>**</sup> | -0.16 (1042) <sup>***</sup> | -0.13 (984) <sup>***</sup> | -0.00 (756) |
| Males           | -0.12 (544) <sup>**</sup>  | -0.10 (581) <sup>*</sup>   | -0.18 (587) <sup>***</sup>  | -0.13 (532) <sup>**</sup>  | 0.03 (400)  |
| Females         | -0.07 (411)                | -0.05 (431)                | -0.08 (455)                 | -0.07 (452)                | 0.01 (356)  |

#### Midlife Variables

|                 |                           |                            |                             |                            |                            |
|-----------------|---------------------------|----------------------------|-----------------------------|----------------------------|----------------------------|
| Physical health | 0.05 (1006)               | 0.10 (1028) <sup>**</sup>  | 0.10 (1173) <sup>***</sup>  | 0.17 (1102) <sup>***</sup> | -0.03 (825)                |
| Males           | -0.00 (571)               | 0.09 (584) <sup>*</sup>    | 0.12 (666) <sup>**</sup>    | 0.15 (601) <sup>***</sup>  | 0.00 (437)                 |
| Females         | 0.10 (435) <sup>*</sup>   | 0.11 (444) <sup>*</sup>    | 0.02 (507)                  | 0.15 (501) <sup>***</sup>  | 0.01 (388)                 |
| Adjustment      | 0.09 (1005) <sup>**</sup> | 0.13 (1028) <sup>***</sup> | 0.14 (1172) <sup>***</sup>  | 0.13 (1102) <sup>***</sup> | 0.07 (825) <sup>*</sup>    |
| Males           | 0.13 (570) <sup>**</sup>  | 0.14 (584) <sup>*</sup>    | 0.16 (665) <sup>*</sup>     | 0.14 (601) <sup>*</sup>    | -0.01 (437) <sup>***</sup> |
| Females         | 0.03 (435) <sup>**</sup>  | 0.11 (444) <sup>**</sup>   | 0.11 (507) <sup>***</sup>   | 0.09 (501)                 | 0.18 (388) <sup>*</sup>    |
| Alcohol use     | 0.08 (1006) <sup>*</sup>  | 0.08 (1027) <sup>*</sup>   | 0.11 (1172) <sup>**</sup>   | 0.06 (1101)                | 0.07 (825) <sup>*</sup>    |
| Males           | 0.07 (571)                | 0.06 (583)                 | 0.12 (665) <sup>**</sup>    | 0.03 (600)                 | 0.03 (437)                 |
| Females         | 0.03 (435)                | 0.05 (444)                 | 0.00 (507)                  | -0.01 (501)                | 0.06 (388)                 |
| Hardships       | -0.02 (983)               | -0.05 (1005)               | -0.12 (1173) <sup>***</sup> | -0.09 (1065) <sup>**</sup> | -0.06 (808)                |
| Males           | 0.01 (559)                | -0.00 (572)                | -0.10 (666) <sup>**</sup>   | -0.07 (580)                | -0.04 (429)                |
| Females         | -0.04 (424)               | -0.08 (433)                | -0.09 (507) <sup>*</sup>    | -0.07 (485)                | -0.01 (379)                |

|   | 1936 Activity             | 1940 activity             | 1950 activity             | 1960 activity             | 1972 activity            |
|---|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|
| Education   | 0.03 (1079)               | 0.014 (1084)              | 0.05 (1173)               | 0.06 (1104) <sup>*</sup>  | 0.02 (845)               |
| Males   | 0.01 (618)                | -0.02 (617)               | -0.00 (666)               | 0.02 (602)                | -0.01 (446)              |
| Females   | -0.00 (461)               | 0.03 (467)                | 0.07 (507)                | 0.06 (502)                | -0.04 (399)              |
| Social ties   | 0.09 (1006) <sup>**</sup> | 0.09 (1028) <sup>**</sup> | 0.08 (1173) <sup>**</sup> | 0.06 (1104) <sup>*</sup>  | 0.02 (845)               |
| Males   | 0.14 (571) <sup>***</sup> | 0.14 (584) <sup>***</sup> | 0.08 (666) <sup>*</sup>   | 0.07 (601)                | -0.02 (437)              |
| Females   | -0.02 (435)               | -0.02 (444)               | 0.05 (507)                | 0.04 (501)                | 0.04 (388)               |
| <b>1986 Healthy Aging &amp; Longevity Variables</b> |                           |                           |                           |                           |                          |
| Physical health                                     | 0.09 (567) <sup>*</sup>   | 0.05 (588)                | 0.08 (650)                | 0.12 (651) <sup>**</sup>  | 0.02 (578)               |
| Males   | 0.05 (303)                | 0.04 (317)                | 0.08 (345)                | 0.03 (343)                | -0.08 (297)              |
| Females   | 0.11 (264)                | 0.05 (271)                | 0.05 (305)                | 0.23 (308) <sup>***</sup> | 0.16 (281) <sup>**</sup> |
| SWB   | 0.06 (567)                | 0.12 (588) <sup>**</sup>  | 0.05 (650)                | 0.11 (651) <sup>**</sup>  | 0.02 (578)               |
| Males   | 0.02 (303)                | 0.06 (317)                | 0.02 (345)                | 0.04 (343)                | -0.07 (297)              |
| Females   | 0.04 (264)                | 0.14 (271) <sup>*</sup>   | 0.01 (305)                | 0.14 (308) <sup>*</sup>   | 0.06 (281)               |
| Social comp   | -0.02 (567)               | 0.02 (588)                | -0.02 (650)               | -0.01 (651)               | -0.09 (578) <sup>*</sup> |
| Males   | -0.01 (303)               | 0.03 (317)                | 0.02 (345)                | 0.06 (343)                | -0.09 (297)              |
| Females   | 0.05 (264)                | 0.07 (271)                | 0.03 (305)                | 0.03 (308)                | 0.04 (281)               |
| Productivity  | -0.04 (567)               | 0.04 (588)                | 0.02 (650)                | 0.04 (651)                | -0.01 (578)              |
| Males   | -0.10 (303)               | 0.00 (317)                | 0.03 (345)                | 0.04 (343)                | -0.01 (297)              |
| Females   | -0.01 (264)               | 0.04 (271)                | -0.08 (305)               | -0.03 (308)               | -0.09 (281)              |
| Age at death  | 0.00 (968)                | -0.05 (971)               | -0.02 (1047)              | -0.02 (980)               | 0.04 (745)               |
| Males   | 0.03 (573)                | -0.04 (568)               | -0.00 (611)               | -0.02 (550)               | 0.05 (406)               |
| Females   | 0.00 (395)                | -0.01 (403)               | 0.02 (436)                | 0.15 (430) <sup>**</sup>  | 0.10 (339)               |

<sup>a</sup> For the physical activity inter-correlations, values above the diagonal refer to Pearson  $r$  correlations for individuals with five measurement occasions for the activity variables ( $N = 533$ ). Values below the diagonal refer to Pearson  $r$  correlations, using the normal pairwise deletion, with the corresponding  $N$  in parentheses.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 3***Terman sample: Analysis of missing data*

a) Patterns of complete (x) and incomplete data.

|         | 1   | 2   | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---------|-----|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1936    | x   | x   | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  | x  |
| 1940    | x   | x   | x  | x  | x  | x  | x  | x  |    |    |    |    |    |    |    |    |
| 1950    | x   | x   | x  | x  |    |    |    |    | x  | x  | x  | x  |    |    |    |    |
| 1960    | x   | x   |    |    | x  | x  |    |    | x  | x  |    |    | x  | x  |    |    |
| 1972    | x   |     | x  |    | x  |    | x  |    | x  |    | x  |    | x  |    | x  |    |
| Full    | 533 | 172 | 16 | 70 | 29 | 14 | 11 | 37 | 65 | 35 | 3  | 26 | 11 | 10 | 3  | 44 |
| Males   | 282 | 109 | 10 | 55 | 13 | 8  | 4  | 25 | 32 | 21 | 1  | 17 | 6  | 7  | 0  | 28 |
| Females | 251 | 63  | 6  | 15 | 16 | 6  | 7  | 12 | 33 | 14 | 2  | 9  | 5  | 3  | 3  | 16 |

|         | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 1936    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 1940    | x  | x  | x  | x  | x  | x  | x  | x  |    |    |    |    |    |    |    |
| 1950    | x  | x  | x  | x  |    |    |    |    | x  | x  | x  | x  |    |    |    |
| 1960    | x  | x  |    |    | x  | x  |    |    | x  | x  |    |    | x  | x  |    |
| 1972    | x  |    | x  |    | x  |    | x  |    | x  |    | x  |    | x  |    | x  |
| Full    | 91 | 38 | 8  | 20 | 5  | 13 | 2  | 25 | 38 | 29 | 9  | 20 | 10 | 11 | 11 |
| Males   | 48 | 20 | 7  | 11 | 5  | 6  | 1  | 13 | 20 | 15 | 5  | 13 | 6  | 4  | 6  |
| Females | 43 | 18 | 1  | 9  | 0  | 7  | 1  | 12 | 18 | 14 | 4  | 7  | 4  | 7  | 5  |

b) Percentage of complete data (i.e., covariance coverage)

|                    | 1936 PA | 1940 PA | 1950 PA | 1960 PA | 1972 PA |
|--------------------|---------|---------|---------|---------|---------|
| <b>1936</b> – Full | 76.6    |         |         |         |         |
| Males              | 77.4    |         |         |         |         |
| Females            | 75.5    |         |         |         |         |
| <b>1940</b> – Full | 62.6    | 76.9    |         |         |         |
| Males              | 63.4    | 77.3    |         |         |         |
| Females            | 61.5    | 76.4    |         |         |         |
| <b>1950</b> – Full | 65.3    | 67.3    | 83.3    |         |         |
| Males              | 66.0    | 67.9    | 83.5    |         |         |
| Females            | 64.3    | 66.4    | 83.0    |         |         |
| <b>1960</b> – Full | 61.7    | 63.5    | 71.0    | 78.4    |         |
| Males              | 59.9    | 61.5    | 68.5    | 75.4    |         |
| Females            | 64.0    | 66.1    | 74.3    | 82.2    |         |
| <b>1972</b> – Full | 47.6    | 49.3    | 54.2    | 55.5    | 60.0    |
| Males              | 43.6    | 46.4    | 50.8    | 51.6    | 55.9    |
| Females            | 52.9    | 53.2    | 58.6    | 60.6    | 65.3    |

c) Maximum likelihood estimates of expected means and standard deviations

|                    | <b>1936</b> | <b>1940</b> | <b>1950</b> | <b>1960</b> | <b>1972</b> |
|--------------------|-------------|-------------|-------------|-------------|-------------|
| <b>Full Sample</b> |             |             |             |             |             |
| <b>Mean</b>        | 3.20        | 3.29        | 3.09        | 2.94        | 2.53        |
| <b>SD</b>          | 1.57        | 1.34        | 1.10        | 1.00        | 0.96        |
| <b>Males</b>       |             |             |             |             |             |
| <b>Mean</b>        | 3.40        | 3.45        | 3.28        | 3.11        | 2.70        |
| <b>SD</b>          | 1.71        | 1.41        | 1.21        | 1.09        | 1.13        |
| <b>Females</b>     |             |             |             |             |             |
| <b>Mean</b>        | 2.93        | 3.08        | 2.84        | 2.72        | 2.34        |
| <b>SD</b>          | 1.33        | 1.22        | 0.88        | 0.83        | 0.67        |

d) Maximum likelihood estimates of expected correlations

|                    | <b>1936 PA</b> | <b>1940 PA</b> | <b>1950 PA</b> | <b>1960 PA</b> | <b>1972 PA</b> |
|--------------------|----------------|----------------|----------------|----------------|----------------|
| <b>1936 – Full</b> | 1.00           |                |                |                |                |
| Males              | 1.00           |                |                |                |                |
| Females            | 1.00           |                |                |                |                |
| <b>1940 – Full</b> | 0.46           | 1.00           |                |                |                |
| Males              | 0.46           | 1.00           |                |                |                |
| Females            | 0.42           | 1.00           |                |                |                |
| <b>1950 – Full</b> | 0.35           | 0.39           | 1.00           |                |                |
| Males              | 0.38           | 0.37           | 1.00           |                |                |
| Females            | .022           | 0.35           | 1.00           |                |                |
| <b>1960 – Full</b> | 0.27           | 0.30           | 0.48           | 1.00           |                |
| Males              | 0.28           | 0.26           | 0.50           | 1.00           |                |
| Females            | 0.19           | 0.31           | 0.37           | 1.00           |                |
| <b>1972 – Full</b> | 0.19           | 0.19           | 0.27           | 0.34           | 1.00           |
| Males              | 0.20           | 0.18           | 0.24           | 0.33           | 1.00           |
| Females            | 0.08           | 0.12           | 0.22           | 0.26           | 1.00           |

**Table 4***Terman sample: Summary of baseline growth curve models (N = 1409, 798 M, 611 F)*

| Model                          | Means       | Linear             | Quadratic         |
|--------------------------------|-------------|--------------------|-------------------|
| <b>Fixed Effects</b>           |             |                    |                   |
| Average Intercept              | 3.04 (0.02) | 3.24 (0.03)        | 3.23 (0.03)       |
| Males                          | 3.22 (0.03) | 3.42 (0.05)        | 3.41 (0.05)       |
| Females                        | 2.80 (0.03) | 2.99 (0.04)        | 2.98 (0.04)       |
| Linear                         | ---         | -0.02 (0.001)      | -0.01 (0.003)     |
| Males                          | ---         | -0.02 (0.002)      | -0.01 (0.004)     |
| Females                        | ---         | -0.02 (0.002)      | -0.01 (0.004)     |
| Quadratic                      | ---         | ---                | -0.0004 (0.0001)  |
| Males                          | ---         | ---                | -0.0005 (0.0001)  |
| Females                        | ---         | ---                | -0.0004 (0.0001)  |
| <b>Random Effects</b>          |             |                    |                   |
| Intercept Variance             | 0.47 (0.03) | 0.93 (0.05)        | 0.98 (0.03)       |
| Males                          | 0.55 (0.05) | 1.09 (0.09)        | 1.06 (0.04)       |
| Females                        | 0.26 (0.03) | 0.79 (0.04)        | 0.82 (0.04)       |
| Intercept-Linear Covariance    | ---         | -0.02 (0.002)      | -0.04 (0.003)     |
| Males                          | ---         | -0.03 (0.003)      | -0.04 (0.005)     |
| Females                        | ---         | -0.02 (0.002)      | -0.04 (0.005)     |
| Linear Variance                | ---         | 0.001 (0.000)      | 0.04 (0.004)      |
| Males                          | ---         | 0.001 (0.000)      | 0.04 (0.006)      |
| Females                        | ---         | 0.000 (0.003)      | 0.04 (0.005)      |
| Intercept-Quadratic Covariance | ---         | ---                | 0.001 (0.0001)    |
| Males                          | ---         | ---                | 0.001 (0.0001)    |
| Females                        | ---         | ---                | 0.001 (0.0001)    |
| Linear-Quadratic Covariance    | ---         | ---                | -0.001 (0.0001)   |
| Males                          | ---         | ---                | -0.001 (0.0002)   |
| Females                        | ---         | ---                | -0.001 (0.0002)   |
| Quadratic Variance             | ---         | ---                | 0.000 (0.0001)    |
| Males                          | ---         | ---                | 0.000 (0.0004)    |
| Females                        | ---         | ---                | 0.000 (0.0001)    |
| Residual Variance              | 1.09 (0.03) | 0.87 (0.02)        | 0.80 (0.02)       |
| Males                          | 1.29 (0.04) | 1.03 (0.04)        | 0.97 (0.04)       |
| Females                        | 0.84 (0.03) | 0.66 (0.02)        | 0.57 (0.02)       |
| <b>Goodness-of-fit</b>         |             |                    |                   |
| Deviance ( $c^2$ )             | 16763       | 16217              | 16125             |
| Males                          | 9850        | 9575               | 9533              |
| Females                        | 6684        | 6353               | 6295              |
| AIC                            | 16769       | 16229              | 16145             |
| Males                          | 9856        | 9587               | 9553              |
| Females                        | 6690        | 6365               | 6315              |
| BIC                            | 16785       | 16261              | 16198             |
| Males                          | 9870        | 9615               | 9600              |
| Females                        | 6704        | 6392               | 6359              |
| $\Delta\chi^2$                 | ---         | 546 <sup>***</sup> | 91 <sup>***</sup> |
| Males                          | ---         | 275 <sup>***</sup> | 42 <sup>***</sup> |
| Females                        | ---         | 331 <sup>***</sup> | 59 <sup>***</sup> |

Note. Standard errors are given in parentheses.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 5***Terman sample: Summary of significant between-person predictors, Males*

| Predictor                | N   | Predictor      |                   |                     |                    |                      | Pseudo R <sup>2</sup> |        | $\Delta\chi^2$ | Conclusion                   |
|--------------------------|-----|----------------|-------------------|---------------------|--------------------|----------------------|-----------------------|--------|----------------|------------------------------|
|                          |     | Intercept      | Linear            | Quadratic           | Intercept          | Linear               | Intercept             | Linear |                |                              |
| <b>Child Personality</b> |     |                |                   |                     |                    |                      |                       |        |                |                              |
| Energy                   | 750 | 3.43<br>(0.05) | -0.006<br>(0.005) | -0.0005<br>(0.0001) | 0.09***<br>(0.02)  | -0.006+<br>(0.005)   | 0.02                  | 0.01   | 24.3           | Intercept,<br>marginal slope |
| Sociability              | 750 | 3.46<br>(0.05) | -0.007<br>(0.005) | -0.0005<br>(0.0001) | 0.05***<br>(0.01)  | -0.007***<br>(0.005) | 0.02                  | 0.01   | 23.7           | Intercept &<br>slope         |
| Conscientiousness        | 750 | 3.42<br>(0.05) | -0.007<br>(0.005) | -0.0004<br>(0.0001) | 0.001<br>(0.01)    | -0.0003<br>(0.0004)  | --                    | --     | 0.8            | Non-significant              |
| Cheerfulness             | 750 | 3.42<br>(0.05) | -0.006<br>(0.005) | -0.0005<br>(0.0001) | 0.01<br>(0.02)     | -0.0008<br>(0.0007)  | --                    | --     | 1.2            | Non-significant              |
| Motivation               | 750 | 3.42<br>(0.05) | -0.006<br>(0.005) | -0.0005<br>(0.0001) | -0.00<br>(0.01)    | 0.0000<br>(0.0004)   | --                    | --     | 0.4            | Non-significant              |
| Permanency of mood       | 750 | 3.42<br>(0.05) | -0.006<br>(0.005) | -0.0004<br>(0.0001) | 0.02<br>(0.03)     | -0.001<br>(0.001)    | --                    | --     | 0.8            | Non-significant              |
| <b>Adult Personality</b> |     |                |                   |                     |                    |                      |                       |        |                |                              |
| Extraversion             | 683 | 3.39<br>(0.05) | -0.003<br>(0.005) | -0.0006<br>(0.0001) | 0.28***<br>(0.07)  | -0.009**<br>(0.003)  | 0.02                  | 0.02   | 15.4           | Intercept &<br>slope         |
| Neuroticism              | 683 | 3.35<br>(0.05) | -0.003<br>(0.005) | -0.0005<br>(0.0001) | -0.37***<br>(0.08) | 0.011***<br>(0.003)  | 0.02                  | 0.02   | 23.7           | Intercept &<br>slope         |
| Conscientiousness        | 683 | 3.37<br>(0.05) | -0.004<br>(0.005) | -0.0005<br>(0.0001) | 0.12<br>(0.07)     | -0.004<br>(0.003)    | --                    | --     | 2.8            | Non-significant              |
| Agreeableness            | 683 | 3.38<br>(0.05) | -0.004<br>(0.005) | -0.0005<br>(0.0001) | -0.04<br>(0.08)    | -0.0006<br>(0.003)   | --                    | --     | 0.7            | Non-significant              |
| <b>Control Variables</b> |     |                |                   |                     |                    |                      |                       |        |                |                              |
| Childhood IQ             | 798 | 3.42<br>(0.05) | -0.006<br>(0.004) | -0.0005<br>(0.0001) | -0.001+<br>(0.004) | 0.0001<br>(0.0002)   | --                    | --     | 3.5            | Marginal<br>Intercept        |
| Child SES                | 557 | 3.42<br>(0.06) | -0.007<br>(0.005) | -0.0005<br>(0.0002) | -0.03<br>(0.02)    | 0.0004<br>(0.0007)   | --                    | --     | 3.1            | Non-significant              |
| Birth weight             | 685 | 3.39<br>(0.05) | -0.007<br>(0.005) | -0.0004<br>(0.0001) | 0.09**<br>(0.03)   | -0.0009<br>(0.001)   | 0.01                  | --     | 10.7           | Intercept                    |
| Infant health            | 688 | 3.42<br>(0.05) | -0.008<br>(0.005) | -0.0004<br>(0.0001) | -0.03<br>(0.06)    | 0.001<br>(0.002)     | --                    | --     | 0.4            | Non-significant              |

| Predictor  | N   | Predictor      |                   |                     | Pseudo R <sup>2</sup> |                    | Δχ <sup>2</sup> | Conclusion |      |                    |
|--|-----|----------------|-------------------|---------------------|-----------------------|--------------------|-----------------|------------|------|--------------------|
|  |     | Intercept      | Linear            | Quadratic           | Intercept             | Linear             |                 |            |      |                    |
| Age of puberty                                   | 492 | 3.41<br>(0.08) | -0.009<br>(0.006) | -0.0004<br>(0.0002) | -0.00<br>(0.05)       | 0.001<br>(0.002)   | --              | --         | 1.1  | Non-significant    |
| Child interest in active pastimes (child report) | 737 | 3.43<br>(0.05) | -0.007<br>(0.005) | -0.0004<br>(0.0001) | 0.23***<br>(0.06)     | -0.005*<br>(0.002) | 0.01            | 0.03       | 17.6 | Intercept & slope  |
| Child activity (parent report)                   | 707 | 3.43<br>(0.05) | -0.004<br>(0.005) | -0.0005<br>(0.0001) | 0.02*<br>(0.01)       | -0.0004<br>(0.005) | 0.004           | --         | 4.2  | Marginal Intercept |
| Body mass index (1940)                           | 679 | 3.38<br>(0.05) | -0.005<br>(0.005) | -0.0005<br>(0.0001) | 0.05**<br>(0.02)      | -0.001<br>(0.0008) | 0.01            | --         | 8.4  | Intercept          |
| Early adult self-rated health (1940)             | 686 | 3.40<br>(0.05) | -0.005<br>(0.005) | -0.0005<br>(0.0001) | 0.20**<br>(0.07)      | -0.003<br>(0.003)  | 0.006           | --         | 10.6 | Intercept          |
| Early adult mental adjustment (1940)             | 752 | 3.41<br>(0.05) | -0.006<br>(0.004) | -0.0005<br>(0.0001) | 0.24**<br>(0.09)      | -0.003<br>(0.004)  | 0.004           | --         | 8.2  | Intercept          |
| Early adult alcohol use (1940)                   | 685 | 3.39<br>(0.05) | -0.005<br>(0.005) | -0.0005<br>(0.0001) | 0.18*<br>(0.09)       | -0.005<br>(0.005)  | 0.003           | --         | 3.9  | Marginal intercept |
| Early adult social ties (1940)                   | 714 | 3.41<br>(0.05) | -0.006<br>(0.004) | -0.0005<br>(0.0001) | 0.04*<br>(0.02)       | -0.001<br>(0.0001) | 0.0001          | --         | 6.1  | Intercept          |

*Note.* Standard errors are given in parentheses. The Pseudo  $R^2$  represents the variance explained by the predictor, compared to the baseline model. The  $\Delta\chi^2$  is based on the baseline quadratic model, adjusted to the number of participants that reported the predictor. +  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 6***Terman sample: Summary of significant between-person predictors, Females*

| Predictor                | N   | Predictor      |                   |                     |                   | Pseudo R <sup>2</sup> |       | $\Delta\chi^2$ | Conclusion |                 |
|--------------------------|-----|----------------|-------------------|---------------------|-------------------|-----------------------|-------|----------------|------------|-----------------|
|                          |     | Intercept      | Linear            | Quadratic           | Intercept         | Linear                |       |                |            |                 |
| <b>Child Personality</b> |     |                |                   |                     |                   |                       |       |                |            |                 |
| Energy                   | 575 | 2.98<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | 0.04 **<br>(0.02) | -0.0004<br>(0.0007)   | 0.01  | --             | 12.1       | Intercept       |
| Sociability              | 575 | 2.97<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | 0.02 *<br>(0.01)  | -0.0004<br>(0.0004)   | 0.004 | --             | 5.7        | Intercept       |
| Conscientiousness        | 575 | 2.99<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | -0.00<br>(0.01)   | 0.0004<br>(0.0004)    | --    | --             | 1.9        | Non-significant |
| Cheerfulness             | 575 | 2.99<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | 0.01<br>(0.02)    | 0.0002<br>(0.0007)    | --    | --             | 2.5        | Non-significant |
| Motivation               | 575 | 2.99<br>(0.04) | -0.009<br>(0.004) | -0.0004<br>(0.0001) | -0.01<br>(0.01)   | 0.0002<br>(0.0004)    | --    | --             | 0.6        | Non-significant |
| Permanency of mood       | 575 | 2.99<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | -0.02<br>(0.03)   | 0.0010<br>(0.0011)    | --    | --             | 0.8        | Non-significant |
| <b>Adult Personality</b> |     |                |                   |                     |                   |                       |       |                |            |                 |
| Extraversion             | 531 | 2.96<br>(0.04) | -0.006<br>(0.004) | -0.0004<br>(0.0001) | 0.14 *<br>(0.07)  | -0.004<br>(0.003)     | 0.01  | --             | 4.3        | Intercept       |
| Neuroticism              | 531 | 2.98<br>(0.04) | -0.007<br>(0.004) | -0.0004<br>(0.0001) | -0.14 *<br>(0.07) | 0.003<br>(0.003)      | 0.004 | --             | 4.5        | Intercept       |
| Conscientiousness        | 531 | 2.97<br>(0.04) | -0.006<br>(0.004) | -0.0004<br>(0.0001) | 0.02<br>(0.07)    | 0.001<br>(0.003)      | --    | --             | 1.3        | Non-significant |
| Agreeableness            | 531 | 2.98<br>(0.04) | -0.006<br>(0.004) | -0.0004<br>(0.0001) | -0.04<br>(0.07)   | 0.0008<br>(0.003)     | --    | --             | 0.3        | Non-significant |
| <b>Control Variables</b> |     |                |                   |                     |                   |                       |       |                |            |                 |
| Childhood IQ             | 611 | 2.98<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | 0.00<br>(0.00)    | -0.0002<br>(0.0002)   | --    | --             | 1.0        | Non-significant |
| Child SES                | 557 | 2.98<br>(0.04) | -0.007<br>(0.004) | -0.0004<br>(0.0001) | 0.02<br>(0.01)    | -0.0004<br>(0.0006)   | --    | --             | 3.3        | Non-significant |
| Birth weight             | 530 | 2.99<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | 0.02<br>(0.03)    | -0.0005<br>(0.002)    | --    | --             | 0.7        | Non-significant |

| Predictor  | N   | Predictor      |                   |                     | Pseudo R <sup>2</sup>         |                                 | Δχ <sup>2</sup> | Conclusion |      |                            |
|--|-----|----------------|-------------------|---------------------|-------------------------------|---------------------------------|-----------------|------------|------|----------------------------|
|  |     | Intercept      | Linear            | Quadratic           | Intercept                     | Linear                          |                 |            |      |                            |
| Infant health                                    | 541 | 2.99<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | -0.03<br>(0.06)               | 0.002<br>(0.002)                | --              | --         | 0.9  | Non-significant            |
| Age of puberty                                   | 548 | 3.04<br>(0.05) | -0.009<br>(0.005) | -0.0004<br>(0.0001) | 0.06 <sup>*</sup><br>(0.04)   | -0.0006<br>(0.001)              | 0.003           | --         | 4.9  | Intercept                  |
| Child interest in active pastimes (child report) | 573 | 2.99<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | 0.12 <sup>*</sup><br>(0.05)   | -0.002<br>(0.002)               | 0.005           | --         | 6.7  | Intercept                  |
| Child activity (parent report)                   | 536 | 2.97<br>(0.04) | -0.009<br>(0.004) | -0.0004<br>(0.000)  | 0.03 <sup>*</sup><br>(0.01)   | -0.0006<br>(0.0006)             | 0.007           | --         | 6.3  | Intercept                  |
| Body mass index (1940)                           | 541 | 2.97<br>(0.04) | -0.006<br>(0.004) | -0.0004<br>(0.0001) | -0.02<br>(0.02)               | 0.0005<br>(0.0006)              | --              | --         | 1.8  | Non-significant            |
| Early adult self-rated health (1940)             | 544 | 3.00<br>(0.04) | -0.007<br>(0.004) | -0.0004<br>(0.0001) | 0.23 <sup>***</sup><br>(0.05) | -0.006 <sup>**</sup><br>(0.002) | 0.03            | 0.003      | 20.4 | Intercept & slope          |
| Early adult mental adjustment (1940)             | 585 | 2.98<br>(0.04) | -0.008<br>(0.004) | -0.0004<br>(0.0001) | 0.23 <sup>**</sup><br>(0.08)  | -0.007 <sup>+</sup><br>(0.003)  | 0.01            | 0.002      | 8.1  | Intercept & marginal slope |
| Early adult alcohol use (1940)                   | 542 | 2.99<br>(0.05) | -0.007<br>(0.004) | -0.0004<br>(0.0001) | 0.02<br>(0.09)                | -0.0004<br>(0.004)              | --              | --         | 0.0  | Non-significant            |
| Early adult social ties (1940)                   | 569 | 2.99<br>(0.04) | -0.007<br>(0.004) | -0.0004<br>(0.0001) | -0.03<br>(0.02)               | 0.001 <sup>*</sup><br>(0.007)   | --              | --         | 3.8  | Marginal slope             |

*Note.* Standard errors are given in parentheses. The Pseudo  $R^2$  represents the variance explained by the predictor, compared to the baseline model. The  $\Delta\chi^2$  is based on the baseline quadratic model, adjusted to the number of participants that reported the predictor.

+  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 7**

*Terman sample: Cross-sectional correlations between physical activity and health variables for the full sample and separately by sex*

A) Early adult cross-sectional relations (1936 and 1940 reports)

|                              | Physical Health<br>(1940)   | Mental Adjustment<br>(1940) |
|------------------------------|-----------------------------|-----------------------------|
| <b>1936 average activity</b> | 0.11 (969) <sup>***</sup>   | 0.06 (1039)                 |
| Males                        | 0.03 (551)                  | 0.05 (593)                  |
| Females                      | 0.20 (418) <sup>***</sup>   | 0.08 (446)                  |
| <b>1940 average activity</b> | 0.14 (1074) <sup>***</sup>  | 0.06 (1081) <sup>*</sup>    |
| Males                        | 0.09 (612) <sup>*</sup>     | 0.04 (614)                  |
| Females                      | 0.17 (462) <sup>***</sup>   | 0.11 (467) <sup>*</sup>     |
| <b>1936 # activities</b>     | -0.01 (911)                 | -0.02 (951)                 |
| Males                        | -0.05 (520)                 | -0.08 (542)                 |
| Females                      | 0.06 (391)                  | 0.08 (409)                  |
| <b>1940 # activities</b>     | 0.03 (1003)                 | 0.06 (1010)                 |
| Males                        | 0.00 (576)                  | 0.03 (579)                  |
| Females                      | 0.08 (427)                  | 0.12 (431) <sup>*</sup>     |
| <b>EB intercept</b>          | 0.16 (1230) <sup>***</sup>  | 0.09 (1337) <sup>***</sup>  |
| Males                        | 0.10 (686) <sup>**</sup>    | 0.09 (752) <sup>*</sup>     |
| Females                      | 0.20 (544) <sup>***</sup>   | 0.11 (585) <sup>**</sup>    |
| <b>EB slope</b>              | -0.10 (1230) <sup>***</sup> | -0.05 (1337)                |
| Males                        | -0.05 (686)                 | -0.04 (752)                 |
| Females                      | -0.16 (544) <sup>***</sup>  | -0.08 (585)                 |

B) Midlife cross-sectional relations (1950 & 1960 reports)

|                              | Physical Health<br>(1950-60) | Mental adjustment<br>(1950-60) |
|------------------------------|------------------------------|--------------------------------|
| <b>1950 average activity</b> | 0.10 (1173) <sup>***</sup>   | 0.14 (1172) <sup>***</sup>     |
| Males                        | 0.12 (666) <sup>**</sup>     | 0.16 (665) <sup>***</sup>      |
| Females                      | 0.02 (507)                   | 0.11 (507) <sup>*</sup>        |
| <b>1960 average activity</b> | 0.17 (1102) <sup>***</sup>   | 0.13 (1102) <sup>***</sup>     |
| Males                        | 0.15 (601) <sup>**</sup>     | 0.14 (601) <sup>**</sup>       |
| Females                      | 0.15 (501) <sup>***</sup>    | 0.09 (501) <sup>*</sup>        |
| <b>1950 # activities</b>     | -0.00 (1042)                 | 0.01 (1041)                    |
| Males                        | -0.05 (587)                  | -0.06 (586)                    |
| Females                      | 0.07 (455)                   | 0.13 (455) <sup>**</sup>       |
| <b>1960 # activities</b>     | -0.03 (984)                  | 0.01 (984)                     |
| Males                        | -0.07 (532)                  | -0.06 (532)                    |
| Females                      | 0.02 (452)                   | 0.11 (452) <sup>*</sup>        |

Note: *N* is indicated in parentheses. EB refers to the empirical Bayes estimates from the growth curve analyses.

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 8**

*Terman sample: Hierarchical linear regression analyses predicting healthy aging from physical activity variables (individual entry, controlling for age) for the full sample (controlling for sex) and separately for males and females.*

| <b>Predictor</b>                  | <b>N</b> | <b><math>\beta</math></b> | <b>t</b> | <b>p</b> | <b>Conclusion</b>        |
|-----------------------------------|----------|---------------------------|----------|----------|--------------------------|
| <b>1986 Physical Health</b>       |          |                           |          |          |                          |
| EB Intercept                      | 715      | 0.07                      | 1.69     | 0.09     | Non-significant          |
| Males                             | 379      | 0.05                      | 0.94     | 0.35     |                          |
| Females                           | 336      | 0.11                      | 1.51     | 0.13     |                          |
| EB Slope                          | 715      | -0.64                     | -0.74    | 0.46     | Non-significant          |
| Males                             | 379      | -1.23                     | -1.13    | 0.26     |                          |
| Females                           | 336      | 0.07                      | 0.06     | 0.96     |                          |
| 1936 activity level               | 567      | 0.04                      | 1.71     | 0.09     | Non-significant          |
| Males                             | 303      | 0.03                      | 1.05     | 0.29     |                          |
| Females                           | 264      | 0.06                      | 1.49     | 0.14     |                          |
| 1940 activity level               | 588      | 0.03                      | 1.18     | 0.24     | Non-significant          |
| Males                             | 317      | 0.04                      | 1.03     | 0.30     |                          |
| Females                           | 271      | 0.03                      | 0.63     | 0.53     |                          |
| 1950 activity level               | 650      | 0.05                      | 1.45     | 0.15     | Non-significant          |
| Males                             | 345      | 0.06                      | 1.40     | 0.16     |                          |
| Females                           | 305      | 0.04                      | 0.59     | 0.56     |                          |
| 1960 activity level               | 651      | 0.10                      | 2.75     | 0.01     | Full sample, females     |
| Males                             | 343      | 0.02                      | 0.55     | 0.59     |                          |
| Females                           | 308      | 0.23                      | 3.72     | 0.000    |                          |
| 1972 activity level               | 578      | -0.01                     | -0.14    | 0.89     | Females only             |
| Males                             | 297      | -0.07                     | -1.60    | 0.11     |                          |
| Females                           | 281      | 0.19                      | 2.28     | 0.02     |                          |
| 1936 # activities                 | 631      | 0.05                      | 1.78     | 0.08     | Non-significant          |
| Males                             | 342      | 0.05                      | 1.51     | 0.13     |                          |
| Females                           | 289      | 0.04                      | 0.96     | 0.34     |                          |
| 1940 # activities                 | 668      | 0.05                      | 1.91     | 0.06     | Marginal for full sample |
| Males                             | 354      | 0.04                      | 1.07     | 0.28     |                          |
| Females                           | 314      | 0.05                      | 1.58     | 0.12     |                          |
| 1950 # activities                 | 690      | 0.00                      | -0.01    | 0.99     | Non-significant          |
| Males                             | 368      | 0.00                      | 0.08     | 0.93     |                          |
| Females                           | 322      | 0.00                      | -0.12    | 0.91     |                          |
| 1960 # activities                 | 661      | 0.01                      | 0.34     | 0.73     | Non-significant          |
| Males                             | 347      | -0.02                     | -0.43    | 0.67     |                          |
| Females                           | 314      | 0.03                      | 0.78     | 0.44     |                          |
| 1972 # activities                 | 632      | 0.04                      | 1.49     | 0.14     | Males only               |
| Males                             | 326      | 0.07                      | 2.03     | 0.04     |                          |
| Females                           | 306      | 0.01                      | 0.19     | 0.85     |                          |
| <b>1986 Subjective Well-being</b> |          |                           |          |          |                          |
| EB Intercept                      | 715      | 0.05                      | 1.73     | 0.08     | Non-significant          |
| Males                             | 379      | 0.03                      | 0.90     | 0.37     |                          |
| Females                           | 336      | 0.10                      | 1.74     | 0.08     |                          |

| Predictor           | N   | $\beta$ | t     | p    | Conclusion           |
|---------------------|-----|---------|-------|------|----------------------|
| EB Slope            | 715 | -0.81   | -1.22 | 0.22 | Non-significant      |
| Males               | 379 | -1.00   | -1.17 | 0.24 |                      |
| Females             | 336 | -0.50   | -0.52 | 0.61 |                      |
| 1936 activity level | 567 | 0.01    | 0.63  | 0.53 | Non-significant      |
| Males               | 303 | 0.01    | 0.44  | 0.66 |                      |
| Females             | 264 | 0.02    | 0.57  | 0.57 |                      |
| 1940 activity level | 588 | 0.05    | 2.31  | 0.02 | Full sample, females |
| Males               | 317 | 0.03    | 1.17  | 0.24 |                      |
| Females             | 271 | 0.08    | 2.30  | 0.02 |                      |
| 1950 activity level | 650 | 0.01    | 0.33  | 0.74 | Non-significant      |
| Males               | 345 | 0.01    | 0.27  | 0.79 |                      |
| Females             | 305 | 0.01    | 0.22  | 0.83 |                      |
| 1960 activity level | 651 | 0.06    | 2.02  | 0.04 | Full sample, females |
| Males               | 343 | 0.02    | 0.68  | 0.50 |                      |
| Females             | 308 | 0.12    | 2.45  | 0.02 |                      |
| 1972 activity level | 578 | -0.02   | -0.59 | 0.54 | Non-significant      |
| Males               | 297 | -0.04   | -1.28 | 0.20 |                      |
| Females             | 281 | 0.06    | 1.00  | 0.32 |                      |
| 1936 # activities   | 631 | 0.01    | 0.41  | 0.68 | Non-significant      |
| Males               | 342 | 0.02    | 0.79  | 0.58 |                      |
| Females             | 289 | 0.00    | 0.09  | 0.93 |                      |
| 1940 # activities   | 668 | 0.02    | 0.91  | 0.36 | Non-significant      |
| Males               | 354 | 0.01    | 0.26  | 0.80 |                      |
| Females             | 314 | 0.03    | 0.98  | 0.33 |                      |
| 1950 # activities   | 690 | 0.02    | 0.92  | 0.36 | Non-significant      |
| Males               | 368 | 0.03    | 1.10  | 0.27 |                      |
| Females             | 322 | 0.01    | 0.22  | 0.83 |                      |
| 1960 # activities   | 661 | 0.01    | 0.33  | 0.75 | Non-significant      |
| Males               | 347 | -0.02   | -0.60 | 0.55 |                      |
| Females             | 314 | 0.03    | 1.00  | 0.32 |                      |
| 1972 # activities   | 632 | -0.01   | -0.45 | 0.65 | Non-significant      |
| Males               | 326 | 0.00    | -0.01 | 0.99 |                      |
| Females             | 306 | -0.02   | -0.61 | 0.55 |                      |

#### 1986 Social Competence

|                     |     |       |       |      |                 |
|---------------------|-----|-------|-------|------|-----------------|
| EB Intercept        | 715 | 0.04  | 1.06  | 0.29 | Non-significant |
| Males               | 379 | 0.02  | 0.39  | 0.70 |                 |
| Females             | 336 | 0.07  | 1.22  | 0.23 |                 |
| EB Slope            | 715 | -0.68 | -0.90 | 0.37 | Non-significant |
| Males               | 379 | -0.41 | -0.41 | 0.69 |                 |
| Females             | 336 | -1.09 | -1.03 | 0.30 |                 |
| 1936 activity level | 567 | 0.00  | 0.25  | 0.80 | Non-significant |
| Males               | 303 | -0.01 | -0.21 | 0.84 |                 |
| Females             | 264 | 0.02  | 0.56  | 0.58 |                 |
| 1940 activity level | 588 | 0.03  | 1.25  | 0.21 | Non-significant |
| Males               | 317 | 0.02  | 0.66  | 0.51 |                 |
| Females             | 271 | 0.04  | 1.11  | 0.27 |                 |
| 1950 activity level | 650 | 0.01  | 0.46  | 0.65 | Non-significant |
| Males               | 345 | 0.01  | 0.04  | 0.78 |                 |
| Females             | 305 | 0.02  | 0.35  | 0.73 |                 |

| Predictor           | N   | $\beta$ | t     | p      | Conclusion                              |
|---------------------|-----|---------|-------|--------|---|
| 1960 activity level | 651 | 0.04    | 1.21  | 0.23   | Non-significant                         |
| Males               | 343 | 0.04    | 1.14  | 0.26   |   |
| Females             | 308 | 0.02    | 0.45  | 0.66   |   |
| 1972 activity level | 578 | -0.04   | -1.22 | 0.22   | Non-significant                         |
| Males               | 297 | -0.06   | -1.63 | 0.10   |   |
| Females             | 281 | 0.02    | 0.31  | 0.76   |   |
| 1936 # activities   | 631 | 0.07    | 3.07  | 0.002  | Full sample, females                    |
| Males               | 342 | 0.06    | 1.76  | 0.08   |   |
| Females             | 289 | 0.08    | 2.44  | 0.02   |   |
| 1940 # activities   | 668 | 0.06    | 2.76  | 0.006  | Full sample, females                    |
| Males               | 354 | 0.05    | 1.74  | 0.08   |   |
| Females             | 314 | 0.06    | 2.18  | 0.03   |   |
| 1950 # activities   | 690 | 0.09    | 3.57  | 0.000  | Full sample, males,<br>females          |
| Males               | 368 | 0.09    | 2.56  | 0.01   |   |
| Females             | 322 | 0.08    | 2.44  | 0.02   |   |
| 1960 # activities   | 661 | 0.07    | 2.98  | 0.003  | Full sample, males;<br>marginal females |
| Males               | 347 | 0.08    | 2.25  | 0.03   |   |
| Females             | 314 | 0.07    | 1.91  | 0.06   |   |
| 1972 # activities   | 632 | 0.14    | 6.63  | <.0001 | Full sample, males,<br>females          |
| Males               | 326 | 0.15    | 5.17  | <.0001 |   |
| Females             | 306 | 0.12    | 4.26  | <.0001 |   |

| 1986 Productivity   |     |       |       |        |                                  |
|---------------------|-----|-------|-------|--------|----------------------------------|
| EB Intercept        | 715 | -0.04 | -1.06 | 0.29   | Non-significant                  |
| Males               | 379 | -0.04 | -0.75 | 0.45   |                                  |
| Females             | 336 | -0.05 | -0.73 | 0.47   |                                  |
| EB Slope            | 715 | 0.96  | 1.17  | 0.24   | Non-significant                  |
| Males               | 379 | 1.57  | 1.39  | 0.17   |                                  |
| Females             | 336 | 0.00  | 0.00  | 0.99   |                                  |
| 1936 activity level | 567 | -0.04 | -1.66 | 0.10   | Non-significant                  |
| Males               | 303 | -0.05 | -1.68 | 0.10   |                                  |
| Females             | 264 | -0.01 | -0.41 | 0.68   |                                  |
| 1940 activity level | 588 | 0.01  | 0.45  | 0.65   | Non-significant                  |
| Males               | 317 | 0.01  | 0.31  | 0.76   |                                  |
| Females             | 271 | 0.02  | 0.44  | 0.66   |                                  |
| 1950 activity level | 650 | -0.02 | -0.53 | 0.59   | Non-significant                  |
| Males               | 345 | 0.02  | 0.42  | 0.68   |                                  |
| Females             | 305 | -0.09 | -1.64 | 0.10   |                                  |
| 1960 activity level | 651 | 0.00  | 0.04  | 0.97   | Non-significant                  |
| Males               | 343 | 0.03  | 0.64  | 0.52   |                                  |
| Females             | 308 | -0.04 | -0.86 | 0.39   |                                  |
| 1972 activity level | 578 | -0.04 | -1.24 | 0.22   | Females – opposite<br>prediction |
| Males               | 297 | -0.01 | -0.30 | 0.77   |                                  |
| Females             | 281 | -0.14 | -2.09 | 0.04   |                                  |
| 1936 # activities   | 631 | 0.10  | 4.23  | <.0001 | Full samples, males,<br>females  |
| Males               | 342 | 0.08  | 2.13  | 0.03   |                                  |
| Females             | 289 | 0.14  | 4.12  | <.0001 |                                  |
| 1940 # activities   | 668 | 0.10  | 4.48  | <.0001 | Full samples, males,<br>females  |
| Males               | 354 | 0.08  | 2.35  | 0.02   |                                  |
| Females             | 314 | 0.11  | 4.11  | <.0001 |                                  |

| <b>Predictor</b>  | <b>N</b> | <b><math>\beta</math></b> | <b>t</b> | <b>p</b> | <b>Conclusion</b>               |
|-------------------|----------|---------------------------|----------|----------|---------------------------------|
| 1950 # activities | 690      | 0.09                      | 3.36     | 0.001    | Full samples, males,<br>females |
| Males             | 368      | 0.10                      | 2.71     | 0.007    |                                 |
| Females           | 322      | 0.07                      | 2.00     | 0.05     |                                 |
| 1960 # activities | 661      | 0.13                      | 5.06     | <.0001   | Full samples, males,<br>females |
| Males             | 347      | 0.16                      | 3.89     | 0.000    |                                 |
| Females           | 314      | 0.11                      | 3.31     | 0.001    |                                 |
| 1972 # activities | 632      | 0.14                      | 6.12     | <.0001   | Full samples, males,<br>females |
| Males             | 326      | 0.18                      | 5.42     | <.0001   |                                 |
| Females           | 306      | 0.09                      | 3.19     | 0.002    |                                 |

**Table 9**

*Terman sample: Summary of significant relations in regression and survival analyses predicting healthy aging and longevity. All analyses controlled for age (and sex in the full sample).*

## A) Significant predictors: Individual variables

| Variable                           | Physical Health | SWB        | Social Competence | Productivity | Mortality   |
|------------------------------------|-----------------|------------|-------------------|--------------|-------------|
| <b>Physical Activity Variables</b> |                 |            |                   |              |             |
| EB intercept                       |                 | Full*, F*  |                   |              |             |
| EB slope                           |                 |            |                   |              |             |
| 1936 activity                      | Full*           |            |                   | Full*, M*    |             |
| 1940 activity                      |                 | Full, F    |                   |              |             |
| 1950 activity                      |                 |            |                   |              |             |
| 1960 activity                      | Full, F         | Full, F    |                   |              | F           |
| 1972 activity                      | F               |            |                   | F            | F*          |
| # activities 1936                  | Full*           |            | Full, M*, F       | Full, M, F   |             |
| # activities 1940                  | Full*           |            | Full, M*, F       | Full, M, F   | Full, F     |
| # activities 1950                  |                 |            | Full, M, F        | Full, M, F   |             |
| # activities 1960                  |                 |            | Full, M, F*       | Full, M, F   | Full, M     |
| # activities 1972                  | M               |            | Full, M, F        | Full, M, F   | Full, M, F  |
| <b>Early Adult Variables</b>       |                 |            |                   |              |             |
| Body mass index                    | Full            |            |                   | F            |             |
| Health                             | Full, M, F      | Full, M, F |                   |              | F           |
| Mental adjustment                  | Full, M, F      | Full, M, F |                   | Full, F*     |             |
| Alcohol use                        |                 | Full*, M*  | Full, F           | Full, M      | Full, F     |
| Social ties                        |                 |            | Full, M, F        | Full, M, F   |             |
| Conscientiousness                  | Full, M, F      | Full, M, F | Full, M, F        | Full, M, F*  | Full, F     |
| Neuroticism                        | Full, M, F      | Full, M, F | Full, F           | F*           | F           |
| Agreeableness                      | Full, M         | Full, M, F | Full, M, F        |              | Full*, F*   |
| Extraversion                       | F*              | Full*, F   | Full, M, F        |              |             |
| <b>Midlife Variables</b>           |                 |            |                   |              |             |
| Health                             | Full, M, F      | Full, M, F | Full*, M*         |              | Full, M*, F |
| Mental adjustment                  | Full, M, F      | Full, M, F | Full, M, F        |              | Full, M*    |
| Alcohol use                        |                 | F          | Full, M           | Full, M*, F  | Full, M, F* |
| Social ties                        |                 |            | Full, M, F        | Full, M, F   | Full, M, F  |
| Hardships                          | F               | Full, F    |                   | Full, M      |             |
| Education                          |                 |            | Full*, F          | Full, M, F   | Full, M     |

*Note:* Full = variable significant in the full sample; M = variable significant for males; F = variable significant for females; \* = variable is marginally significant (p value is between .05 and .10).

B) Activity variables controlling for significant 1940 control variables <sup>◊</sup>

| Variable          | Physical Health | SWB      | Social Competence | Productivity | Mortality  |
|-------------------|-----------------|----------|-------------------|--------------|------------|
| EB intercept      |                 |          |                   |              |            |
| EB slope          |                 |          |                   |              |            |
| 1936 activity     |                 |          |                   | Full, M, F*  |            |
| 1940 activity     |                 | Full*, F |                   |              |            |
| 1950 activity     |                 |          |                   |              |            |
| 1960 activity     | F               | F*       |                   |              | Full, F    |
| 1972 activity     | F*              |          |                   | Full, F      | Full, F    |
| # activities 1936 | Full*, M        |          | Full, F*          | Full, M*, F  |            |
| # activities 1940 |                 |          | Full, F           | Full, M*, F  | Full, F    |
| # activities 1950 |                 |          | Full, M, F        | Full, M      |            |
| # activities 1960 |                 |          | Full, M           | Full, M, F   | M          |
| # activities 1972 |                 |          | Full, M, F        | Full, M, F   | Full, M, F |

<sup>◊</sup> For physical health, controls were health, adjustment, BMI, conscientiousness, neuroticism, extraversion, and agreeableness. For SWB, controls were health, adjustment, alcohol use, conscientiousness, neuroticism, extraversion, and agreeableness. For social competence, controls were alcohol use, and social ties, conscientiousness, neuroticism, extraversion, and agreeableness. For productivity, controls were alcohol use, conscientiousness, neuroticism, and social ties. For mortality, controls were health, alcohol use, conscientiousness, and neuroticism.

## C) Early adult individual activity variables predicting midlife variables

|                   | Health     | Adjustment | Alcohol | Social Ties | Education   |
|-------------------|------------|------------|---------|-------------|-------------|
| EB intercept      | Full, M, F | Full, M, F | Full, M | Full, M     |             |
| EB slope          |            | Full, M    |         | Full, M     |             |
| 1936 activity     | F          | Full, M    | Full*   | Full, M     |             |
| 1940 activity     | Full, M, F | Full, M, F | Full*   | Full, M     |             |
| 1950 activity     | Full, M    | Full, M, F | Full, M | Full, M     | F*          |
| # activities 1936 | F*         |            |         | Full, M, F* | Full, M*, F |
| # activities 1940 | Full, F    |            | Full, F | Full, M*    | Full, F     |
| # activities 1950 | Full, M    |            | Full, M | Full, M, F  | F           |

D) Early adult individual activity variables predicting healthy aging, controlling for significant midlife variables <sup>◊</sup>

|                   | Physical Health | SWB | Social Competence | Productivity | Mortality |
|-------------------|-----------------|-----|-------------------|--------------|-----------|
| EB intercept      |                 |     | ---               | ---          | ---       |
| 1936 activity     | Full*           | --- | ---               | Full*, M*    | ---       |
| 1940 activity     | ---             |     | ---               | ---          | ---       |
| # activities 1936 | ---             | --- | Full              | Full, M, F   | ---       |
| # activities 1940 | Full*, F*       | --- | Full              | Full, M, F   | F         |
| # activities 1950 | ---             | --- | Full, M*, F       | Full, M, F*  | ---       |

<sup>◊</sup> For physical health and SWB, midlife variables were health and adjustment. For social competence and productivity, midlife variables were alcohol use, social ties, and education. For mortality risk, midlife variables were health, alcohol use, social ties, and education.

**Table 10***Terman sample: Joint growth-outcome analyses*

| Model  | Intercept on outcome |      |       | Slope on outcome |       |       | Conclusion |
|--|----------------------|------|-------|------------------|-------|-------|------------|
|  | b                    | SE   | b/ SE | b                | SE    | b/SE  |            |
| <b>Average activity level predicting survival</b>      |                      |      |       |                  |       |       |            |
| Linear   | 0.51                 | 0.28 | 1.84  | 18.16            | 10.65 | 1.71  |            |
| 1940 controls  | 0.62                 | 0.31 | 2.01  | 22.17            | 11.91 | 1.86  | intercept  |
| Quadratic  | 0.12                 | 0.38 | 0.33  | 2.02             | 0.22  | 0.25  |            |
| 1940 controls  | 0.16                 | 0.43 | 0.38  | 2.54             | 9.32  | 0.30  |            |
| <b>Average activity level predicting healthy aging</b> |                      |      |       |                  |       |       |            |
| Linear- Physical health                                | 0.08                 | 0.16 | 0.49  | 0.82             | 5.16  | 0.16  |            |
| With controls  | 0.03                 | 0.18 | 0.17  | 0.65             | 0.70  | 0.09  |            |
| Linear-SWB   | 0.01                 | 0.13 | 0.04  | -2.55            | 4.78  | -0.53 |            |
| With controls  | -0.05                | 0.12 | -0.44 | -3.41            | 4.17  | -0.82 |            |
| Linear-social competence                               | -0.07                | 0.14 | -0.48 | -4.39            | 4.71  | -0.93 |            |
| With controls  | -0.10                | 0.13 | -0.79 | -4.72            | 4.09  | -1.15 |            |
| Linear-productivity                                    | -0.24                | 0.16 | -1.54 | -7.56            | 5.61  | -1.35 |            |
| With controls  | -0.25                | 0.17 | -1.53 | -6.99            | 6.11  | -1.15 |            |
| Quadratic- Physical health                             | 0.08                 | 0.19 | 0.41  | 0.66             | 3.74  | 0.18  |            |
| With controls  | -0.03                | 0.13 | -0.24 | -0.69            | 2.02  | -0.34 |            |
| Quadratic-SWB  | 0.13                 | 0.19 | 0.68  | 1.44             | 4.24  | 0.34  |            |
| With controls  | 0.04                 | 0.11 | 0.34  | 0.17             | 1.92  | 0.09  |            |
| Quadratic-social competence                            | 0.20                 | 0.14 | 1.50  | 3.27             | 2.31  | 1.42  |            |
| With controls  | 0.20                 | 0.12 | 1.75  | 3.81             | 1.83  | 2.08  | slope      |
| Quadratic-productivity                                 | 0.13                 | 0.14 | 0.88  | 3.59             | 2.43  | 1.48  |            |
| With controls  | 0.13                 | 0.13 | 1.02  | 4.11             | 2.00  | 2.06  | slope      |

| Model  | Intercept on outcome |      |       | Slope on outcome |      |       | Conclusion                |
|--|----------------------|------|-------|------------------|------|-------|---------------------------|
|  | b                    | SE   | b/ SE | b                | SE   | b/SE  |                           |
| <b>Number of activities predicting survival</b>      |                      |      |       |                  |      |       |                           |
| Linear   | 0.08                 | 0.04 | 1.99  | 4.62             | 2.09 | 2.20  | slope, marginal intercept |
| 1940 controls  | 0.07                 | 0.04 | 1.77  | 4.95             | 2.19 | 2.27  | slope                     |
| Quadratic  | 0.06                 | 0.06 | 1.01  | 4.33             | 2.70 | 1.06  |                           |
| 1940 controls  | 0.05                 | 0.06 | 0.91  | 4.54             | 2.90 | 1.57  |                           |
| <b>Number of activities predicting healthy aging</b> |                      |      |       |                  |      |       |                           |
| Linear- Physical health                              | 0.09                 | 0.04 | 2.20  | 2.27             | 1.02 | 2.23  | intercept & slope         |
| With controls  | 0.05                 | 0.04 | 1.27  | 2.00             | 0.86 | 2.33  | slope                     |
| Linear-SWB   | 0.04                 | 0.03 | 1.34  | -0.77            | 0.51 | -1.50 |                           |
| With controls  | 0.01                 | 0.03 | 0.33  | -0.88            | 1.16 | -0.76 |                           |
| Linear-social competence                             | 0.17                 | 0.04 | 5.00  | 5.75             | 1.38 | 4.16  | intercept & slope         |
| With controls  | 0.14                 | 0.03 | 4.09  | 5.10             | 0.86 | 5.91  | intercept & slope         |
| Linear-productivity                                  | 0.21                 | 0.04 | 5.68  | 6.59             | 0.80 | 8.28  | intercept & slope         |
| With controls  | 0.17                 | 0.04 | 4.48  | 7.37             | 0.71 | 10.39 | intercept & slope         |
| Quadratic- Physical health                           | 0.08                 | 0.06 | 1.18  | 1.04             | 3.16 | 0.33  |                           |
| With controls  | 0.04                 | 0.04 | 1.10  | 1.17             | 0.57 | 2.04  | slope                     |
| Quadratic-SWB  | 0.05                 | 0.04 | 1.31  | -2.31            | 0.49 | -4.75 | slope                     |
| With controls  | 0.02                 | 0.03 | 0.68  | -2.00            | 1.31 | -1.52 |                           |
| Quadratic-social competence                          | 0.16                 | 0.05 | 3.42  | 2.45             | 0.67 | 3.65  | intercept & slope         |
| With controls  | 0.13                 | 0.04 | 3.29  | 2.63             | 0.82 | 3.20  | intercept & slope         |
| Quadratic-productivity                               | 0.20                 | 0.04 | 4.96  | 3.16             | 0.74 | 4.29  | intercept & slope         |
| With controls  | 0.17                 | 0.04 | 4.52  | 3.86             | 1.08 | 3.57  | intercept & slope         |

*Note:* "With controls" include age, sex, physical health, mental adjustment, social ties, and personality (conscientiousness, neuroticism, extraversion, and agreeableness). Models predicting survival included 1,143 participants. Models predicting aging included 616 participants.

**Table 11***PHAB sample: Descriptives*

| <b>Variable</b>                | <b>N</b> | <b>Mean</b> | <b>Std</b> | <b>Median</b> | <b>Min</b> | <b>Max</b> |
|--------------------------------|----------|-------------|------------|---------------|------------|------------|
| Conscientiousness              | 284      | 40.36       | 7.03       | 40.00         | 17.00      | 56.00      |
| Extraversion                   | 284      | 36.44       | 8.00       | 36.00         | 11.00      | 53.00      |
| Neuroticism                    | 284      | 29.65       | 8.06       | 30.00         | 8.00       | 51.00      |
| Openness                       | 284      | 42.68       | 7.57       | 43.00         | 18.00      | 56.00      |
| Agreeableness                  | 284      | 42.63       | 6.73       | 42.00         | 23.00      | 56.00      |
| Drive for success              | 307      | 33.78       | 5.27       | 34.00         | 13.00      | 45.00      |
| Perceived benefits             | 299      | 11.71       | 7.81       | 12.00         | -8.00      | 26.00      |
| Perceived barriers             | 300      | 13.03       | 9.45       | 11.00         | 0.00       | 52.00      |
| Locus of control               | 307      | 19.73       | 6.61       | 19.00         | 7.00       | 44.00      |
| Support to be active           | 295      | 7.31        | 3.27       | 7.00          | 3.00       | 15.00      |
| Number of social ties          | 284      | 4.86        | 2.30       | 4.00          | 1.00       | 11.00      |
| Relationship quality           | 307      | 3.83        | 0.71       | 3.83          | 1.33       | 5.00       |
| Neighborhood safety            | 298      | 3.26        | 1.10       | 3.00          | 1.00       | 5.00       |
| Active neighbors               | 300      | 3.00        | 1.07       | 3.00          | 1.00       | 5.00       |
| Childhood activity             | 301      | 3.46        | 0.95       | 3.50          | 1.00       | 5.00       |
| Prolonged injury               | 295      | 0.51        | 0.50       | 1.00          | 0.00       | 1.00       |
| Leisure time METs              | 286      | 4.88        | 2.43       | 6.00          | 0.90       | 9.50       |
| Activity METs                  | 299      | 4.76        | 2.14       | 5.50          | 0.90       | 9.00       |
| Effort level                   | 298      | 2.92        | 1.20       | 2.86          | 1.00       | 6.00       |
| Fitness level                  | 300      | 3.06        | 0.93       | 3.00          | 1.00       | 5.00       |
| Exercises 20+ min              | 252      | 2.55        | 0.87       | 3.00          | 1.00       | 4.00       |
| Activity rating                | 302      | 2.98        | 1.38       | 3.00          | 0.67       | 6.00       |
| Physical activity <sup>a</sup> | 307      | 1.99        | 0.79       | 2.09          | 0.25       | 3.56       |
| Physical health                | 307      | 12.98       | 2.74       | 13.00         | 5.00       | 19.00      |
| Subjective well-being          | 307      | 3.51        | 0.58       | 3.57          | 1.86       | 4.86       |
| Satisfaction with life         | 307      | 3.45        | 0.59       | 3.50          | 1.60       | 4.60       |
| Depression                     | 307      | 31.12       | 9.73       | 29.00         | 13.00      | 65.00      |
| Stressful life events          | 306      | 14.28       | 9.18       | 13.00         | 0.00       | 43.00      |
| Body mass index                | 279      | 23.75       | 5.07       | 22.67         | 15.82      | 51.49      |
| Age                            | 284      | 19.79       | 2.17       | 19.00         | 18.00      | 29.00      |
| Sex <sup>b</sup>               | 307      | 0.71        | 0.58       | 1.00          | 0.00       | 2.00       |

<sup>a</sup> Physical activity is an averaged composite of the six activity variables (leisure time METs, activity METs, effort level, fitness level, exercises for 20 minutes, and activity rating). <sup>b</sup> For sex, 0 = male, 1 = females.

**Table 12***PHAB sample: Physical activity cluster analysis results (z score values)*

| Variable            | Cluster 1:<br>Inactive | Cluster 2:<br>Mixed | Cluster 3:<br>Active |
|---------------------|------------------------|---------------------|----------------------|
| N                   | 94                     | 57                  | 156                  |
| Leisure activity    | -1.35                  | 0.16                | 0.70                 |
| Most often activity | -0.93                  | -0.51               | 0.72                 |
| Effort level        | -0.66                  | -0.46               | 0.54                 |
| Fitness level       | -0.63                  | -0.53               | 0.56                 |
| Exercise 20 minutes | -0.66                  | -0.28               | 0.50                 |
| Activity rating     | -0.97                  | -0.50               | 0.75                 |

**Mean level Patterns Across Groups**

Legend: Cluster 1 (blue), Cluster 2 (red), Cluster 3 (green)

**Activity variable descriptives by clusters**

| Variable            | Cluster 1 |      |      |      | Cluster 2 |      |      |      | Cluster 3 |      |      |      |
|---------------------|-----------|------|------|------|-----------|------|------|------|-----------|------|------|------|
|                     | Mean      | Std  | Min  | Max  | Mean      | Std  | Min  | Max  | Mean      | Std  | Min  | Max  |
| Leisure activity    | 1.59      | 0.55 | 0.90 | 3.50 | 5.28      | 1.11 | 3.40 | 7.00 | 6.60      | 1.27 | 1.50 | 9.50 |
| Most often activity | 2.76      | 1.81 | 0.90 | 8.00 | 3.66      | 1.56 | 1.00 | 6.00 | 6.31      | 0.96 | 3.50 | 9.00 |
| Effort level        | 2.11      | 0.91 | 1.00 | 5.00 | 2.37      | 0.96 | 1.00 | 6.00 | 3.57      | 1.04 | 1.75 | 6.00 |
| Fitness level       | 2.48      | 0.78 | 1.00 | 5.00 | 2.56      | 0.77 | 1.00 | 4.50 | 3.57      | 0.75 | 1.75 | 5.00 |
| Exercise 20 min     | 1.96      | 0.82 | 1.00 | 4.00 | 2.32      | 0.84 | 1.00 | 4.00 | 2.99      | 0.65 | 2.00 | 4.00 |
| Activity rating     | 1.63      | 0.74 | 0.67 | 4.00 | 2.30      | 0.57 | 1.33 | 4.00 | 4.02      | 0.98 | 2.00 | 6.00 |

**Table 13***PHAB sample: Variable descriptives, by physical activity cluster*

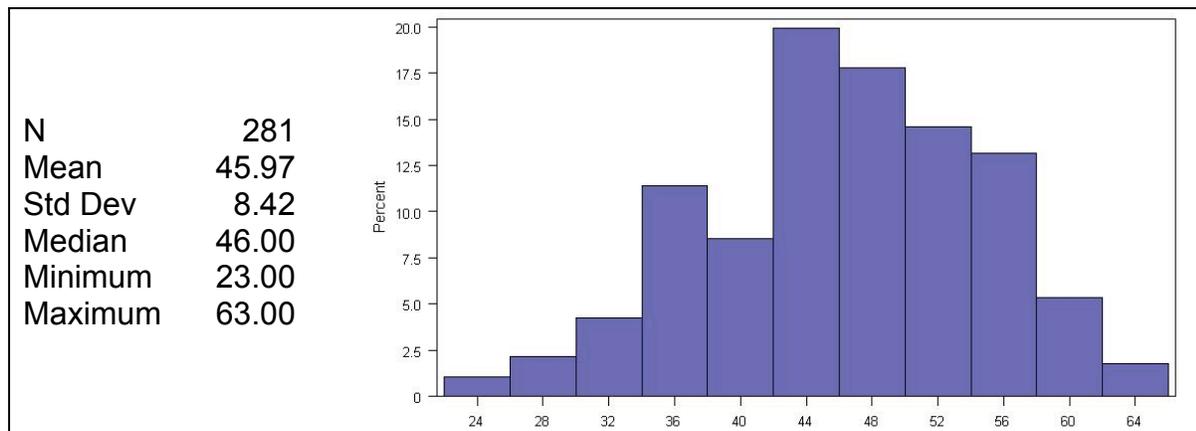
| Variable               | Cluster 1 |       |       | Cluster 2 |       |      | Cluster 3 |       |      |
|------------------------|-----------|-------|-------|-----------|-------|------|-----------|-------|------|
|                        | N         | Mean  | Std   | N         | Mean  | Std  | N         | Mean  | Std  |
| Conscientiousness      | 88        | 39.00 | 7.98  | 50        | 40.60 | 6.53 | 146       | 41.10 | 6.49 |
| Extraversion           | 88        | 35.42 | 7.43  | 50        | 35.12 | 9.04 | 146       | 37.51 | 7.86 |
| Neuroticism            | 88        | 31.69 | 8.30  | 50        | 30.20 | 8.72 | 146       | 28.23 | 7.42 |
| Openness               | 88        | 41.70 | 8.17  | 50        | 42.80 | 7.91 | 146       | 43.22 | 7.06 |
| Agreeableness          | 88        | 41.80 | 6.24  | 50        | 42.70 | 6.40 | 146       | 43.12 | 7.12 |
| Drive for success      | 94        | 33.30 | 5.31  | 57        | 33.33 | 5.13 | 156       | 34.22 | 5.30 |
| Perceived benefits     | 90        | 9.23  | 7.22  | 56        | 11.32 | 7.68 | 153       | 13.30 | 7.84 |
| Perceived barriers     | 91        | 16.23 | 10.61 | 56        | 15.32 | 9.66 | 153       | 10.28 | 7.71 |
| Locus of control       | 94        | 21.19 | 7.29  | 57        | 20.89 | 7.02 | 156       | 18.42 | 5.75 |
| Support to be active   | 91        | 6.41  | 2.50  | 53        | 6.89  | 3.29 | 151       | 8.00  | 3.53 |
| Number of social ties  | 88        | 4.89  | 2.18  | 51        | 4.53  | 2.43 | 145       | 4.96  | 2.32 |
| Relationship quality   | 94        | 3.70  | 0.76  | 57        | 3.86  | 0.68 | 156       | 3.89  | 0.68 |
| Neighborhood safety    | 90        | 3.20  | 1.07  | 56        | 3.18  | 1.16 | 152       | 3.32  | 1.09 |
| Active neighbors       | 91        | 2.84  | 0.99  | 56        | 3.05  | 1.07 | 153       | 3.08  | 1.11 |
| Childhood activity     | 91        | 3.17  | 0.92  | 56        | 3.26  | 0.87 | 154       | 3.71  | 0.93 |
| Prolonged injury       | 89        | 0.34  | 0.48  | 55        | 0.38  | 0.49 | 151       | 0.66  | 0.47 |
| Physical activity      | 94        | 1.13  | 0.45  | 57        | 1.64  | 0.40 | 156       | 2.64  | 0.36 |
| Physical health        | 94        | 11.71 | 2.27  | 57        | 11.67 | 2.77 | 156       | 14.22 | 2.42 |
| Subjective well-being  | 94        | 3.31  | 0.60  | 57        | 3.40  | 0.51 | 156       | 3.67  | 0.53 |
| Satisfaction with life | 94        | 3.33  | 0.65  | 57        | 3.42  | 0.60 | 156       | 3.55  | 0.54 |
| Depression             | 94        | 33.09 | 10.83 | 57        | 31.89 | 8.89 | 156       | 29.65 | 9.13 |
| Stressful life events  | 94        | 13.61 | 9.92  | 56        | 13.02 | 8.51 | 156       | 15.14 | 8.92 |
| Body mass index        | 86        | 24.56 | 6.50  | 50        | 24.35 | 6.03 | 143       | 23.06 | 3.40 |
| Age                    | 88        | 19.52 | 1.70  | 51        | 19.55 | 1.63 | 145       | 20.03 | 2.54 |
| Sex                    | 88        | 0.73  | 0.45  | 52        | 0.67  | 0.47 | 147       | 0.54  | 0.50 |

Note: Cluster 1 = inactive group, cluster 2 = moderate/mixed group, cluster 3 = active group.

**Table 14***PHAB sample: Contrast t-test comparisons of physical activity clusters*

| Variable              | N   | Contrast 1  |             |             |       |        |      | Contrast 2  |             |             |       |        |      | Pattern    |
|-----------------------|-----|-------------|-------------|-------------|-------|--------|------|-------------|-------------|-------------|-------|--------|------|------------|
|                       |     | $\lambda_1$ | $\lambda_2$ | $\lambda_3$ | t     | p      | r    | $\lambda_1$ | $\lambda_2$ | $\lambda_3$ | t     | p      | r    |            |
| Conscientiousness     | 284 | -1          | 0           | 1           | 2.23  | .03    | 0.13 | -1          | -1          | 2           | 1.54  | .13    | 0.09 | Contrast 1 |
| Extraversion          | 284 | -1          | 0           | 1           | 1.94  | .05    | 0.12 | -1          | -1          | 2           | 2.32  | .02    | 0.14 | Contrast 2 |
| Neuroticism           | 284 | 1           | 0           | -1          | 3.24  | .001   | 0.19 | 1           | 1           | -2          | 2.83  | .005   | 0.17 | Contrast 1 |
| Openness              | 284 | -1          | 0           | 1           | 1.48  | .14    | 0.09 | -1          | -1          | 2           | 1.05  | .30    | 0.06 | Non-sig    |
| Agreeableness         | 284 | -1          | 0           | 1           | 1.45  | .15    | 0.09 | -1          | -1          | 2           | 1.06  | .29    | 0.06 | Non-sig    |
| Drive for success     | 307 | -1          | 0           | 1           | 1.35  | .18    | 0.08 | -1          | -1          | 2           | 1.49  | .14    | 0.08 | Non-sig    |
| Perceived benefits    | 299 | -1          | 0           | 1           | 4.01  | <.0001 | 0.23 | -1          | -1          | 2           | 3.38  | .001   | 0.19 | Contrast 1 |
| Perceived barriers    | 300 | 1           | 0           | -1          | 4.97  | <.0001 | 0.28 | 1           | 1           | -2          | 5.18  | <.0001 | 0.29 | Contrast 2 |
| Perceived control     | 307 | 1           | 0           | -1          | 3.27  | .001   | 0.18 | 1           | 1           | -2          | 3.48  | .001   | 0.20 | Contrast 2 |
| Support for activity  | 295 | -1          | 0           | 1           | 3.75  | .000   | 0.21 | -1          | -1          | 2           | 3.56  | .000   | 0.20 | Contrast 1 |
| Social Ties           | 284 | -1          | 0           | 1           | 0.23  | .82    | 0.01 | -1          | -1          | 2           | 0.90  | .37    | 0.05 | Non-sig    |
| Relation quality      | 307 | -1          | 0           | 1           | 2.00  | .05    | 0.11 | -1          | -1          | 2           | 1.28  | .20    | 0.07 | Contrast 1 |
| Safe environment      | 298 | -1          | 0           | 1           | 0.84  | .40    | 0.05 | -1          | -1          | 2           | 1.03  | .30    | 0.06 | Non-sig    |
| Active neighbors      | 399 | -1          | 0           | 1           | 1.72  | .09    | 0.10 | -1          | -1          | 2           | 1.07  | .29    | 0.06 | Non-sig    |
| Child activity        | 301 | -1          | 0           | 1           | 4.51  | <.0001 | 0.25 | -1          | -1          | 2           | 4.68  | <.0001 | 0.26 | Contrast 2 |
| Prolonged injury      | 295 | -1          | 0           | 1           | 5.09  | <.0001 | 0.29 | -1          | -1          | 2           | 5.36  | <.0001 | 0.30 | Contrast 2 |
| Physical health       | 307 | -1          | 0           | 1           | 7.85  | <.0001 | 0.41 | -1          | -1          | 2           | 8.92  | <.0001 | 0.46 | Contrast 2 |
| SWB                   | 307 | -1          | 0           | 1           | 5.00  | <.0001 | 0.28 | -1          | -1          | 2           | 4.88  | <.0001 | 0.27 | Contrast 1 |
| Life satisfaction     | 307 | -1          | 0           | 1           | 2.87  | .004   | 0.16 | -1          | -1          | 2           | 2.55  | .01    | 0.14 | Contrast 1 |
| Depression            | 307 | 1           | 0           | -1          | 2.73  | .007   | 0.15 | 1           | 1           | -2          | 2.54  | .01    | 0.14 | Contrast 1 |
| Stressful life events | 306 | 1           | 0           | -1          | -1.28 | .20    | 0.07 | 1           | 1           | -2          | -1.71 | .09    | 0.10 | Reversed   |
| Body mass index       | 279 | 1           | 0           | -1          | 2.18  | .03    | 0.13 | 1           | 1           | -2          | 2.27  | .02    | 0.14 | Contrast 2 |
| Age                   | 284 | 1           | 0           | -1          | -1.73 | .09    | 0.10 | 1           | 1           | -2          | -1.88 | .06    | 0.11 | Reversed   |
| Sex                   | 287 | 1           | 0           | -1          | 2.93  | .004   | 0.17 | 1           | 1           | -2          | 2.82  | .005   | 0.17 | Contrast 1 |

Note: Contrast 1 tests a linear prediction; contrast 2 compares clusters 1 and 2 (inactive and moderate groups) to cluster 3 (active group).

**Table 15***PHAB sample: Active personality descriptives and correlations with other variables***Correlations with other variables:**

| Variable              | N   | Corr  | P      |
|-----------------------|-----|-------|--------|
| Conscientiousness     | 281 | 0.78  | <.0001 |
| Extraversion          | 281 | 0.58  | <.0001 |
| Neuroticism           | 281 | -0.21 | .001   |
| Openness              | 281 | 0.61  | <.0001 |
| Agreeableness         | 281 | 0.48  | <.0001 |
| Drive for success     | 281 | 0.38  | <.0001 |
| Perceived benefits    | 279 | 0.27  | <.0001 |
| Perceived barriers    | 280 | -0.30 | <.0001 |
| Perceived control     | 281 | -0.40 | <.0001 |
| Support for activity  | 275 | 0.09  | .16    |
| Social Ties           | 279 | 0.20  | .001   |
| Relation quality      | 281 | 0.40  | <.0001 |
| Safe environment      | 278 | 0.13  | .04    |
| Active neighbors      | 280 | 0.08  | .18    |
| Child activity        | 281 | 0.19  | .001   |
| Prolonged injury      | 276 | 0.21  | .001   |
| Physical activity     | 281 | 0.40  | <.0001 |
| Physical health       | 281 | 0.46  | <.0001 |
| Subjective well-being | 281 | 0.40  | <.0001 |
| Life satisfaction     | 281 | 0.45  | <.0001 |
| Depression            | 281 | -0.37 | <.0001 |
| Stressful life events | 281 | 0.17  | .004   |
| Body mass index       | 272 | -0.14 | .02    |
| Age                   | 279 | 0.17  | .005   |
| Sex                   | 281 | -0.08 | .19    |

**Table 16***PHAB sample: Regression model results*

|   | Model fit                          | Estimate | t-test               | Partial r |
|---|------------------------------------|----------|----------------------|-----------|
| <b>Model A: Baseline</b>                      | N = 287                            |          |                      |           |
| Sex   | F = 15.60<br>R <sup>2</sup> = 0.05 | -0.37    | -3.95 <sup>***</sup> | 0.05      |
| <b>Model B: Active Personality</b>            | N = 281                            |          |                      |           |
| Sex   | F = 36.89                          | -0.34    | -4.01 <sup>***</sup> | 0.05      |
| Active personality                            | R <sup>2</sup> = 0.21              | 0.04     | 7.26 <sup>***</sup>  | 0.15      |
| <b>Model C: Individual Aspects</b>            | N = 279                            |          |                      |           |
| Sex   | F = 24.09                          | -0.30    | -3.57 <sup>***</sup> | 0.03      |
| Active personality                            | R <sup>2</sup> = 0.31              | 0.02     | 4.89 <sup>***</sup>  | 0.06      |
| Perceived benefits                            |                                    | 0.01     | 1.70                 | 0.01      |
| Perceived barriers                            |                                    | -0.02    | -4.84 <sup>***</sup> | 0.06      |
| Child activity                                |                                    | 0.10     | 2.29 <sup>*</sup>    | 0.01      |
| <b>Model D: Social Aspects</b>                | N = 272                            |          |                      |           |
| Sex   | F = 23.19                          | -0.34    | -3.98 <sup>***</sup> | 0.04      |
| Active personality                            | R <sup>2</sup> = 0.26              | 0.04     | 7.30 <sup>***</sup>  | 0.15      |
| Safe environment                              |                                    | -0.03    | -0.90                | 0.00      |
| Social support for activity                   |                                    | 0.05     | 3.70 <sup>***</sup>  | 0.04      |
| <b>Model E: Interactions</b>                  | N = 272                            |          |                      |           |
| Sex   | F = 15.98                          | -0.33    | -3.85 <sup>***</sup> | 0.04      |
| Active personality                            | R <sup>2</sup> = 0.27              | 0.04     | 7.30 <sup>***</sup>  | 0.15      |
| Safe environment                              |                                    | -0.03    | -0.85                | 0.00      |
| Personality x environment                     |                                    | -0.01    | -1.68                | 0.01      |
| Social support for activity                   |                                    | 0.05     | 3.68 <sup>***</sup>  | 0.04      |
| Personality x support                         |                                    | 0.00     | 0.30                 | 0.00      |
| <b>Model F: Final Model</b>                   | N = 274                            |          |                      |           |
| Sex   | F = 25.67                          | -0.27    | -3.27 <sup>***</sup> | 0.03      |
| Active personality                            | R <sup>2</sup> = 0.32              | 0.03     | 5.44 <sup>***</sup>  | 0.07      |
| Perceived barriers                            |                                    | -0.02    | -4.48 <sup>***</sup> | 0.05      |
| Child activity                                |                                    | 0.09     | 2.09 <sup>*</sup>    | 0.01      |
| Social support for activity                   |                                    | 0.04     | 3.20 <sup>***</sup>  | 0.03      |
| <b>Predicting Physical Health<sup>a</sup></b> | N = 280                            |          |                      |           |
| Physical activity                             | F = 60.89                          | 1.27     | 6.70 <sup>***</sup>  | 0.10      |
| Active personality                            | R = 0.40                           | 0.09     | 5.01 <sup>***</sup>  | 0.05      |
| Perceived barriers                            |                                    | -0.06    | -3.83 <sup>***</sup> | 0.03      |

<sup>a</sup> The individual and social variables tested above were tested in a full model but were non-significant.

\*  $p < .05$ , \*\*  $p < .01$ ,  $p < .001$

**Table 17**

*Cross study validation: Correlations of the PHAB study individual, social, and health variables with the physical activity and active personality variables created above versus the comparable item in the Terman sample.*

| Variable                          | Physical Activity |          |            | Active Personality |          |            |
|-----------------------------------|-------------------|----------|------------|--------------------|----------|------------|
|                                   | Phab              | Sub      | Conclusion | Phab               | Sub      | Conclusion |
| Conscientiousness                 | 0.14*             | 0.09     | Phab only  | 0.78***            | 0.45***  | both       |
| Extraversion                      | 0.17**            | 0.03     | Phab only  | 0.58***            | 0.40***  | both       |
| Neuroticism                       | -0.19**           | -0.13*   | both       | -0.21***           | -0.30*** | both       |
| Openness                          | 0.10              | 0.08     | Non-sig    | 0.61***            | 0.37***  | both       |
| Agreeableness                     | 0.03              | 0.08     | Non-sig    | 0.48***            | 0.27***  | both       |
| Drive for success <sup>a</sup>    | 0.11              | 0.02     | Non-sig    | 0.38***            | 0.42***  | both       |
| Ambition <sup>a</sup>             | 0.04              | -0.03    | Non-sig    | 0.29***            | 0.31***  | both       |
| Success <sup>a</sup>              | 0.16**            | 0.09     | Phab only  | 0.35***            | 0.40***  | both       |
| Perceived benefits                | 0.20***           | 0.23***  | both       | 0.27***            | 0.18**   | both       |
| Perceived barriers                | -0.39***          | -0.23*** | both       | -0.30***           | -0.36*** | both       |
| Locus of control                  | -0.24***          | -0.16**  | both       | -0.40***           | -0.34*** | both       |
| Support to be active              | 0.23***           | 0.13*    | both       | 0.08               | 0.09     | Non-sig    |
| Number of social ties             | 0.00              | -0.03    | Non-sig    | 0.20***            | 0.18**   | both       |
| Relationship quality              | 0.11              | 0.06     | Non-sig    | 0.40***            | 0.29***  | both       |
| Neighborhood safety               | 0.04              | 0.05     | Non-sig    | 0.13*              | 0.08     | Phab only  |
| Active neighbors                  | 0.13*             | 0.07     | Phab only  | 0.08               | 0.02     | Non-sig    |
| Childhood activity                | 0.28***           | 0.17**   | both       | 0.19**             | 0.18**   | both       |
| Prolonged injury                  | 0.33***           | 0.23***  | both       | 0.21***            | 0.13*    | both       |
| Physical health                   | 0.55***           | 0.38***  | both       | 0.46***            | 0.47***  | both       |
| General health <sup>b</sup>       | 0.43***           | 0.28***  | both       | 0.39***            | 0.42***  | both       |
| Energy <sup>b</sup>               | 0.51***           | 0.38***  | both       | 0.42***            | 0.40***  | both       |
| Subjective well-being             | 0.31***           | 0.22***  | both       | 0.40***            | 0.45***  | both       |
| Satisfaction with life            | 0.19**            | 0.10     | Phab only  | 0.45***            | 0.39***  | both       |
| Satisfaction reduced <sup>c</sup> | 0.17**            | 0.06     | Phab only  | 0.41***            | 0.35***  | both       |
| Depression                        | -0.19**           | -0.16**  | both       | -0.37***           | -0.28*** | both       |
| Stressful life events             | 0.08              | 0.01     | Non-sig    | 0.17**             | 0.13*    | both       |
| Body mass index                   | -0.19**           | -0.13*   | both       | -0.14*             | -0.19**  | both       |
| Age                               | 0.13*             | 0.16**   | both       | 0.17**             | 0.04     | Phab only  |
| Sex                               | -0.16**           | -0.05    | Phab only  | -0.08              | -0.07    | Non-sig    |
| Active personality                | 0.40              | 0.25     | both       | 1.00               | 0.60***  | inter-corr |
| Terman var                        | 0.31              | 0.15     | both       | 0.60***            | 1.00     | inter-corr |
| Physical activity                 | 1.00              | 0.77***  | inter-corr | 0.40***            | 0.31***  | both       |
| Terman activity                   | 0.77***           | 1.00     | inter-corr | 0.25***            | 0.15*    | both       |

Note: Phab refers to the variables described above. Sub refers to the comparable variable from the Terman study. Finding summarizes which correlations are significant.

<sup>a</sup> Success and ambition came from the Terman data, but were measured in different years, therefore two separate variables were created here (both  $\alpha = 0.79$ ). <sup>b</sup> General health and energy are part of the composite physical health scale, and were measured in the Terman data. <sup>c</sup> Eight of the satisfaction with life variables came from the Terman data; these were combined into a life satisfaction subscale ( $\alpha = 0.77$ )

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Table 18**

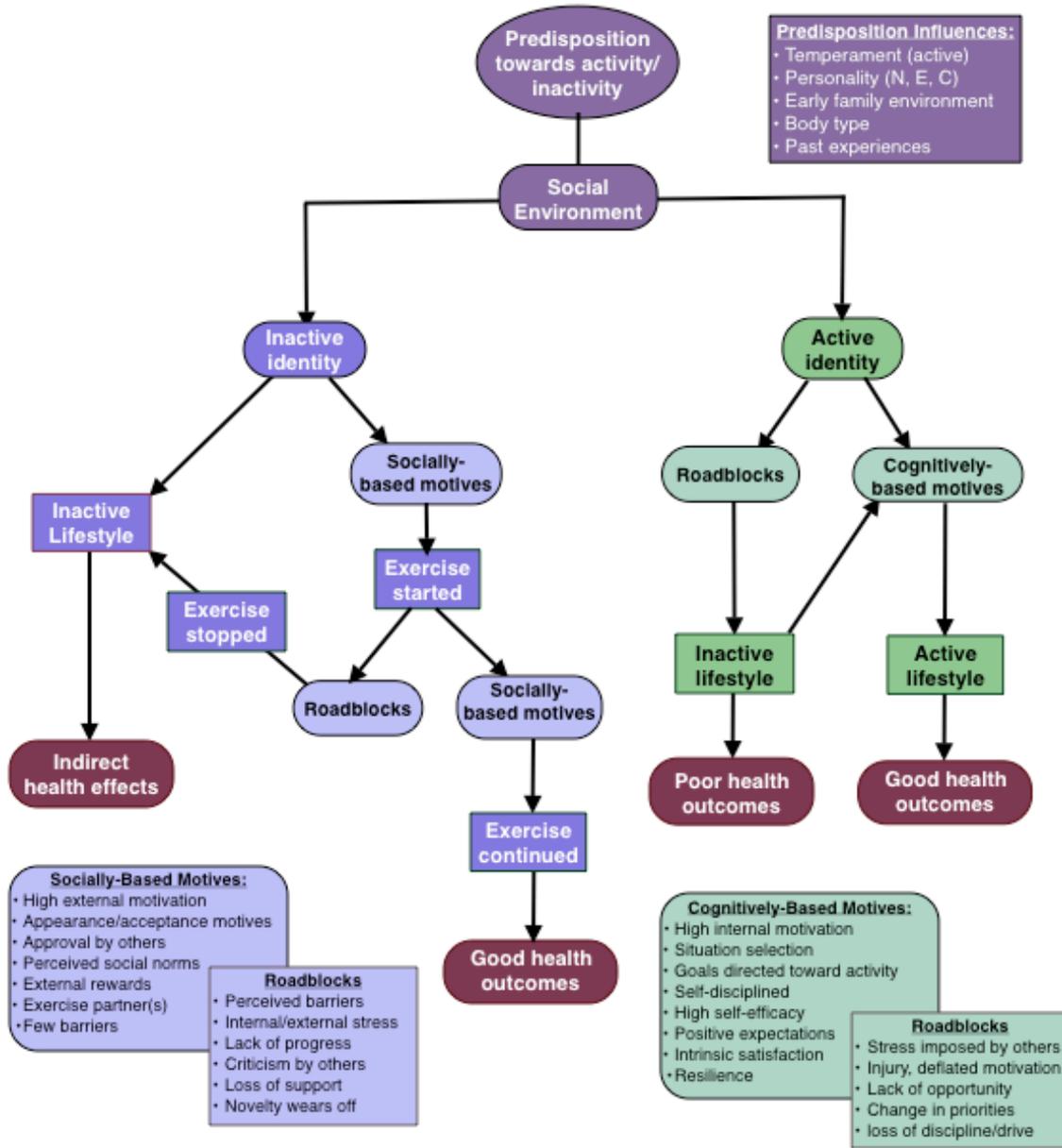
*Cross-study validation: Correlations of physical activity and active personality variables and other variables measured in the Terman sample.*

| Variable                 | 1940 Act <sup>a</sup> | 1950 Act <sup>a</sup> | Child Pers <sup>b</sup> | Adult Pers <sup>b</sup> |
|--------------------------|-----------------------|-----------------------|-------------------------|-------------------------|
| Physical activity        |                       |                       |                         |                         |
| 1940                     | 1.00                  | 0.39 <sup>***</sup>   | 0.02                    | 0.09 <sup>**</sup>      |
| 1950                     | 0.39 <sup>***</sup>   | 1.00                  | -0.01                   | 0.08 <sup>*</sup>       |
| Active personality       |                       |                       |                         |                         |
| Child                    | 0.02                  | -0.01                 | 1.00                    | 0.08 <sup>**</sup>      |
| Adult                    | 0.09 <sup>**</sup>    | 0.08 <sup>*</sup>     | 0.08 <sup>**</sup>      | 1.00                    |
| 1940 Personality         |                       |                       |                         |                         |
| Conscientiousness        | 0.04                  | 0.06 <sup>*</sup>     | 0.05                    | 0.72 <sup>***</sup>     |
| Extraversion             | 0.15 <sup>***</sup>   | 0.08 <sup>**</sup>    | 0.07 <sup>*</sup>       | 0.08 <sup>**</sup>      |
| Neuroticism              | -0.10 <sup>**</sup>   | -0.16 <sup>***</sup>  | -0.06 <sup>*</sup>      | -0.21 <sup>**</sup>     |
| Agreeableness            | -0.05                 | -0.04                 | 0.05                    | -0.08 <sup>**</sup>     |
| Success                  | 0.18 <sup>***</sup>   | 0.18 <sup>***</sup>   | 0.02                    | 0.26 <sup>***</sup>     |
| Drive for ambition       | 0.08 <sup>*</sup>     | 0.09 <sup>**</sup>    | 0.06 <sup>*</sup>       | 0.24 <sup>***</sup>     |
| Self-rated health        |                       |                       |                         |                         |
| 1940                     | 0.14 <sup>***</sup>   | 0.15 <sup>***</sup>   | 0.07 <sup>*</sup>       | 0.08 <sup>**</sup>      |
| 1950                     | 0.08 <sup>**</sup>    | 0.10 <sup>***</sup>   | 0.04                    | 0.04                    |
| Energy (1950)            | 0.11 <sup>***</sup>   | 0.15 <sup>***</sup>   | 0.07 <sup>*</sup>       | 0.23 <sup>***</sup>     |
| Life satisfaction (1950) | 0.05                  | 0.02                  | 0.02                    | 0.18 <sup>***</sup>     |
| BMI                      | 0.10 <sup>***</sup>   | 0.05                  | 0.05                    | 0.12 <sup>***</sup>     |
| Sex                      | -0.14 <sup>***</sup>  | -0.20 <sup>***</sup>  | 0.11 <sup>***</sup>     | -0.11 <sup>***</sup>    |

<sup>a</sup> PA = Physical activity (average MET value). <sup>b</sup> Composite active personality trait, in childhood (1922 ratings by parents and teachers) and adulthood (1940 self-ratings)

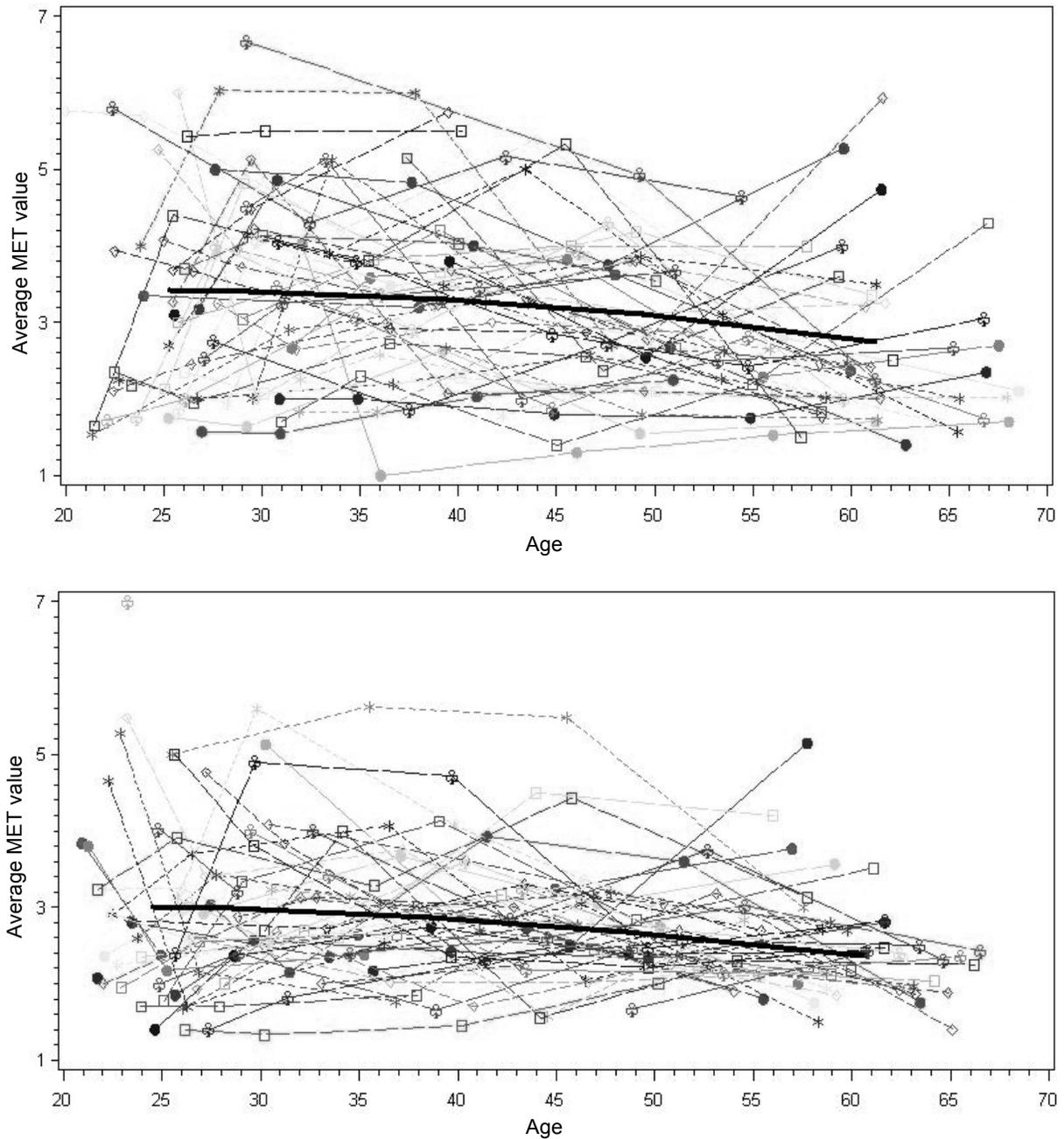
\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

**Figure 1**  
*Theoretical model*



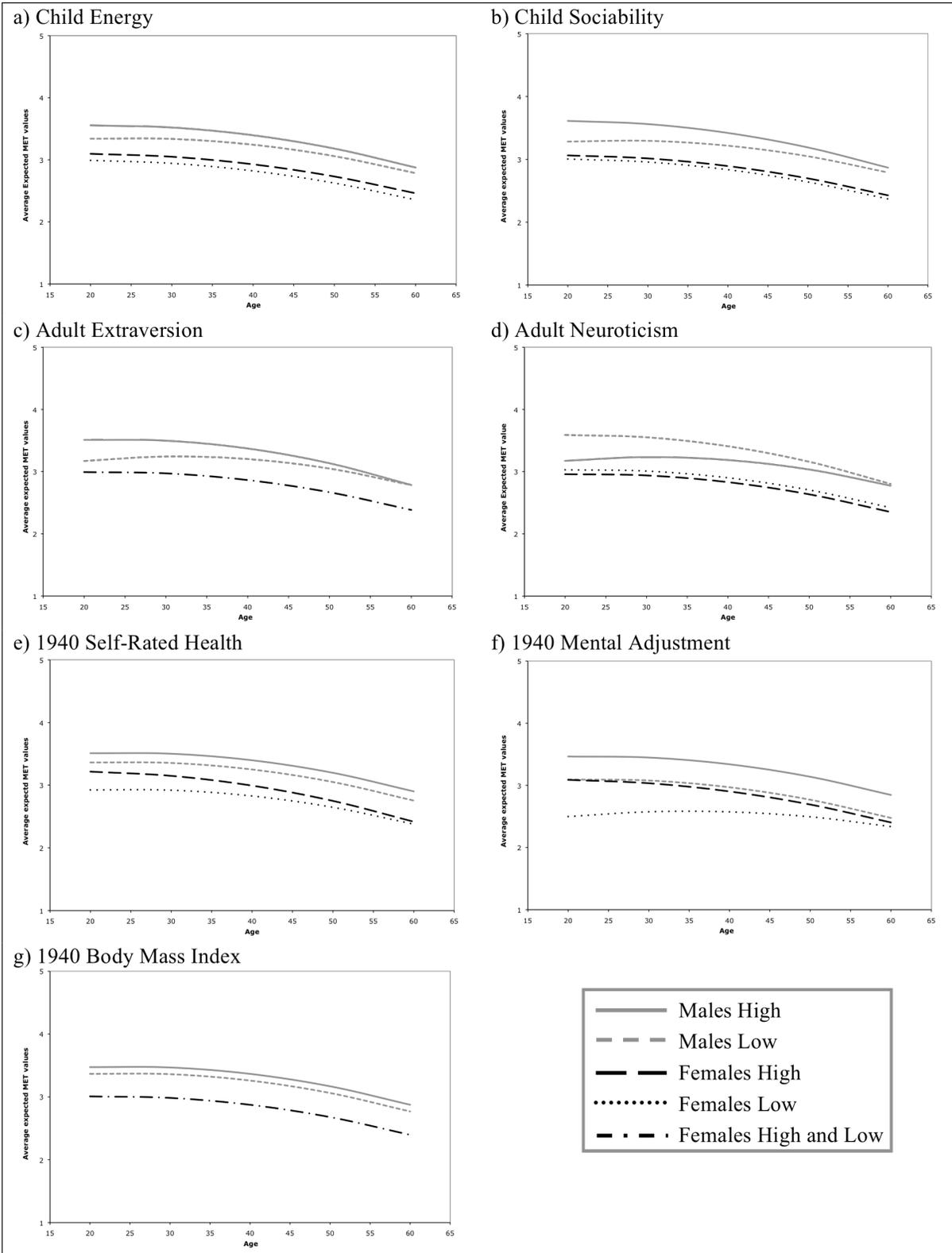
**Figure 2**

*Terman sample: Sample plots of physical activity patterns over age for two random samples of 50 males (top) and 50 females (bottom), with the average trajectory across the full sample (N = 1409) superimposed (bold line).*



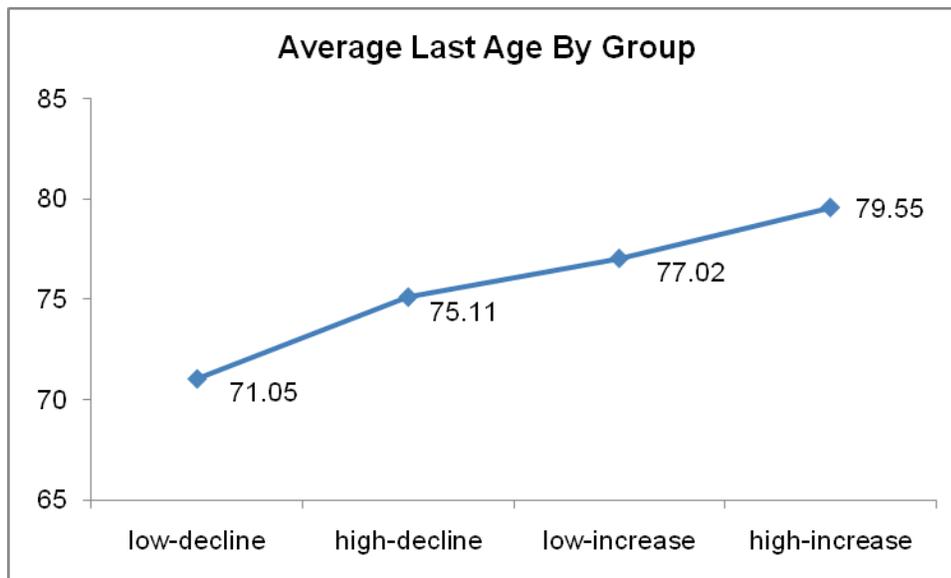
**Figure 3**

*Terman sample: Expected trajectories of physical activity for eight significant predictor variables for an individual low on the variable (one standard deviation below the mean) and an individual high on the variable (one standard deviation above the mean), separately by sex.*

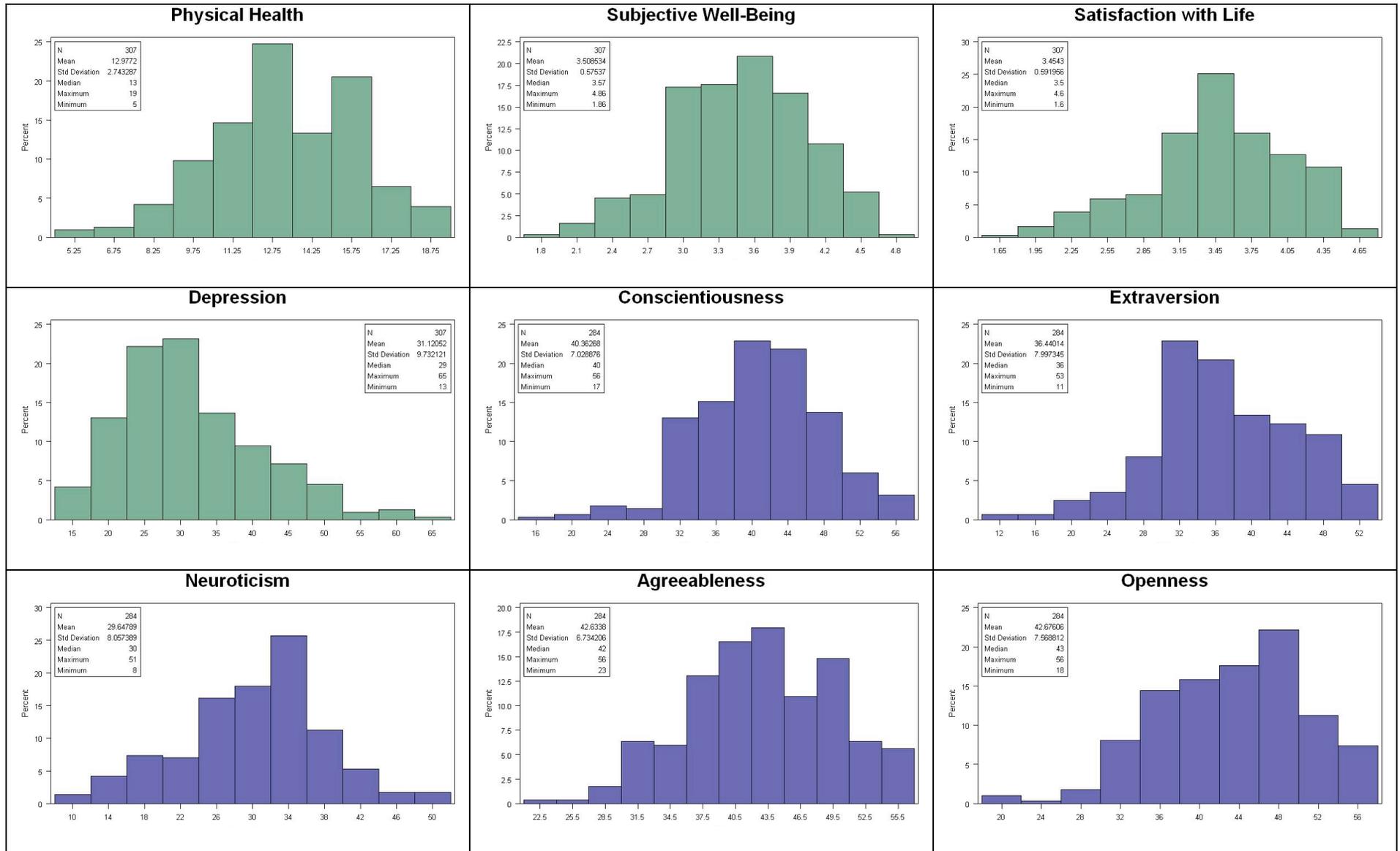


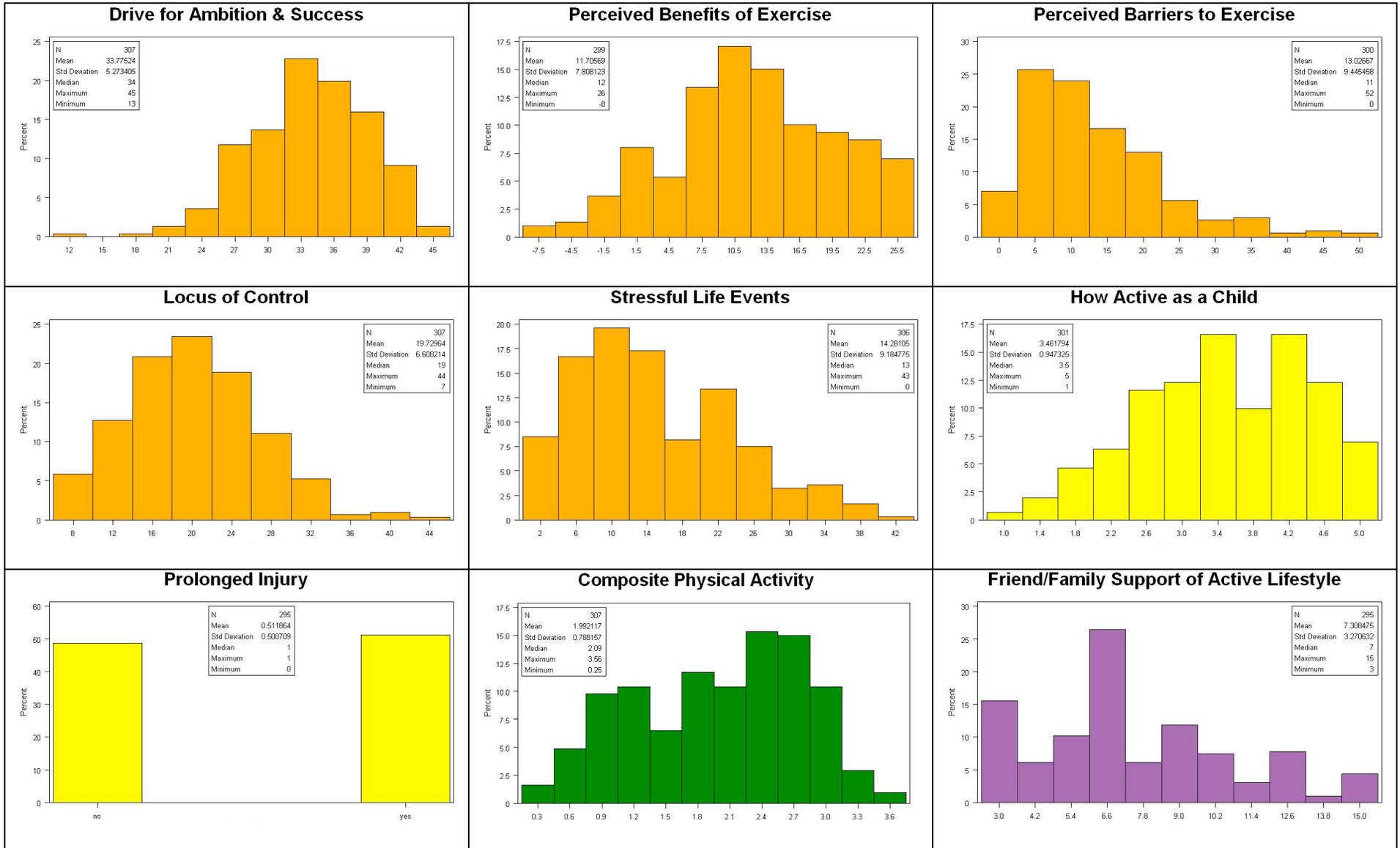
**Figure 4**

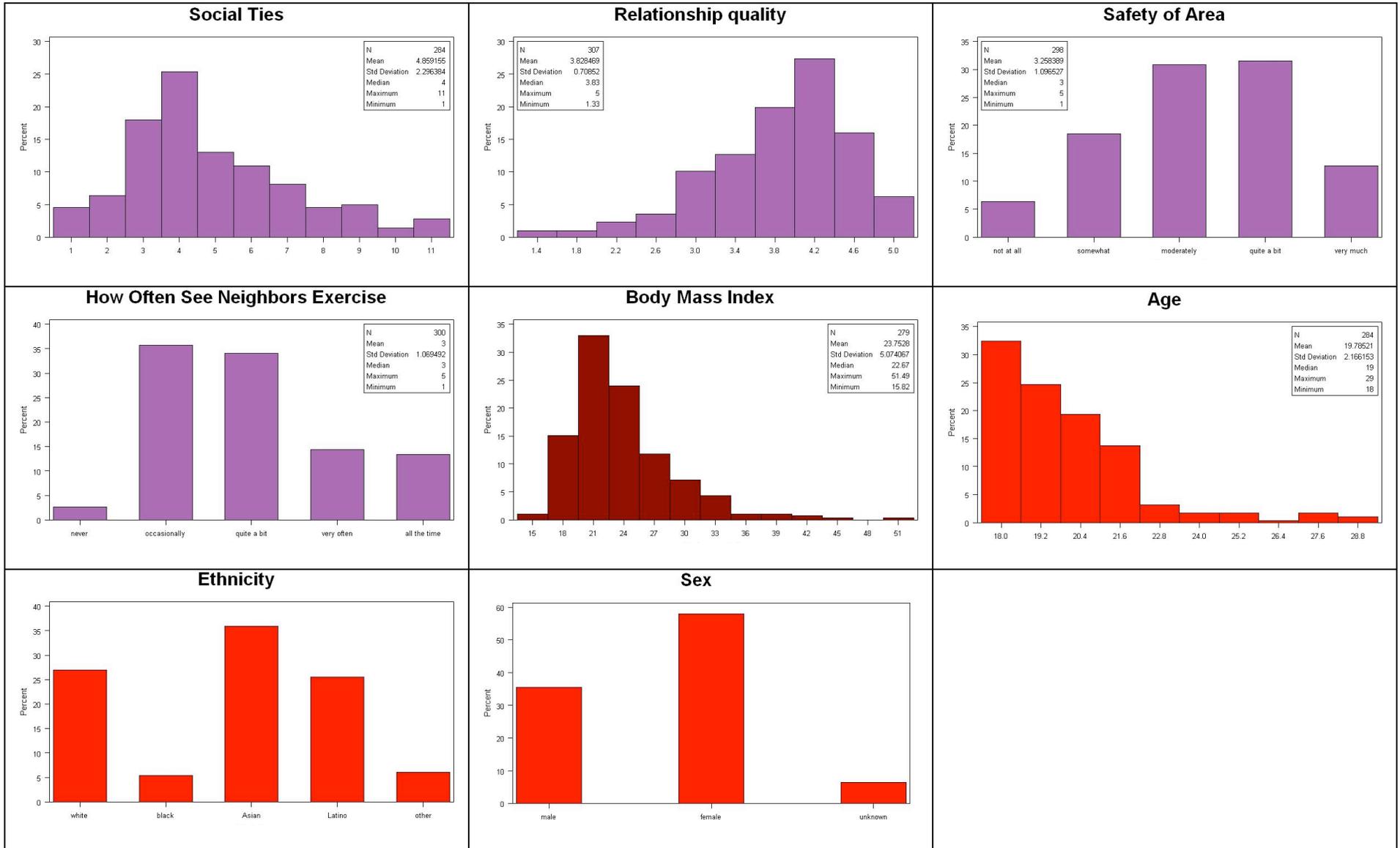
*Terman sample: Mean plots of last age by group*



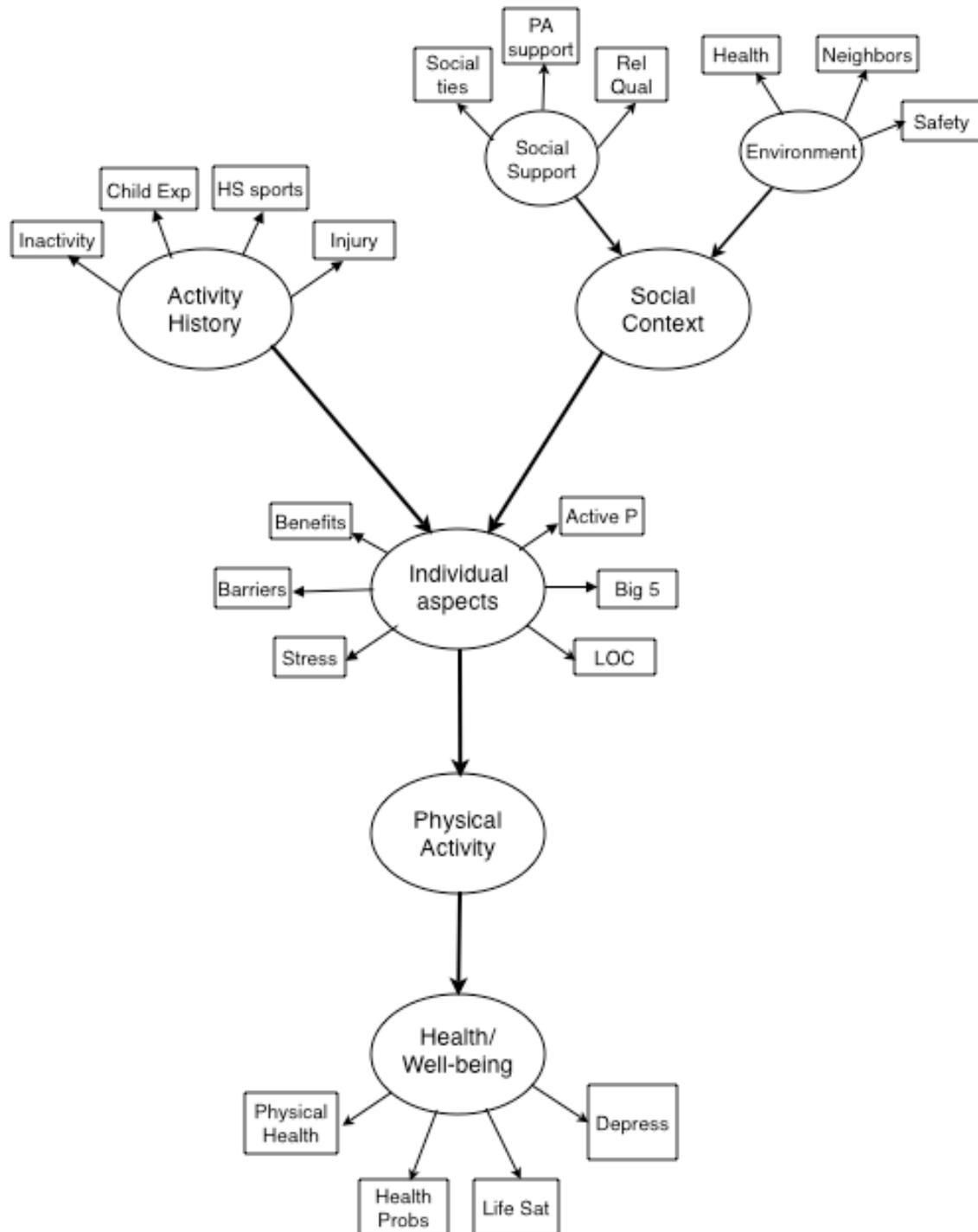
**Figure 5**  
*PHAB study: Descriptive statistics*



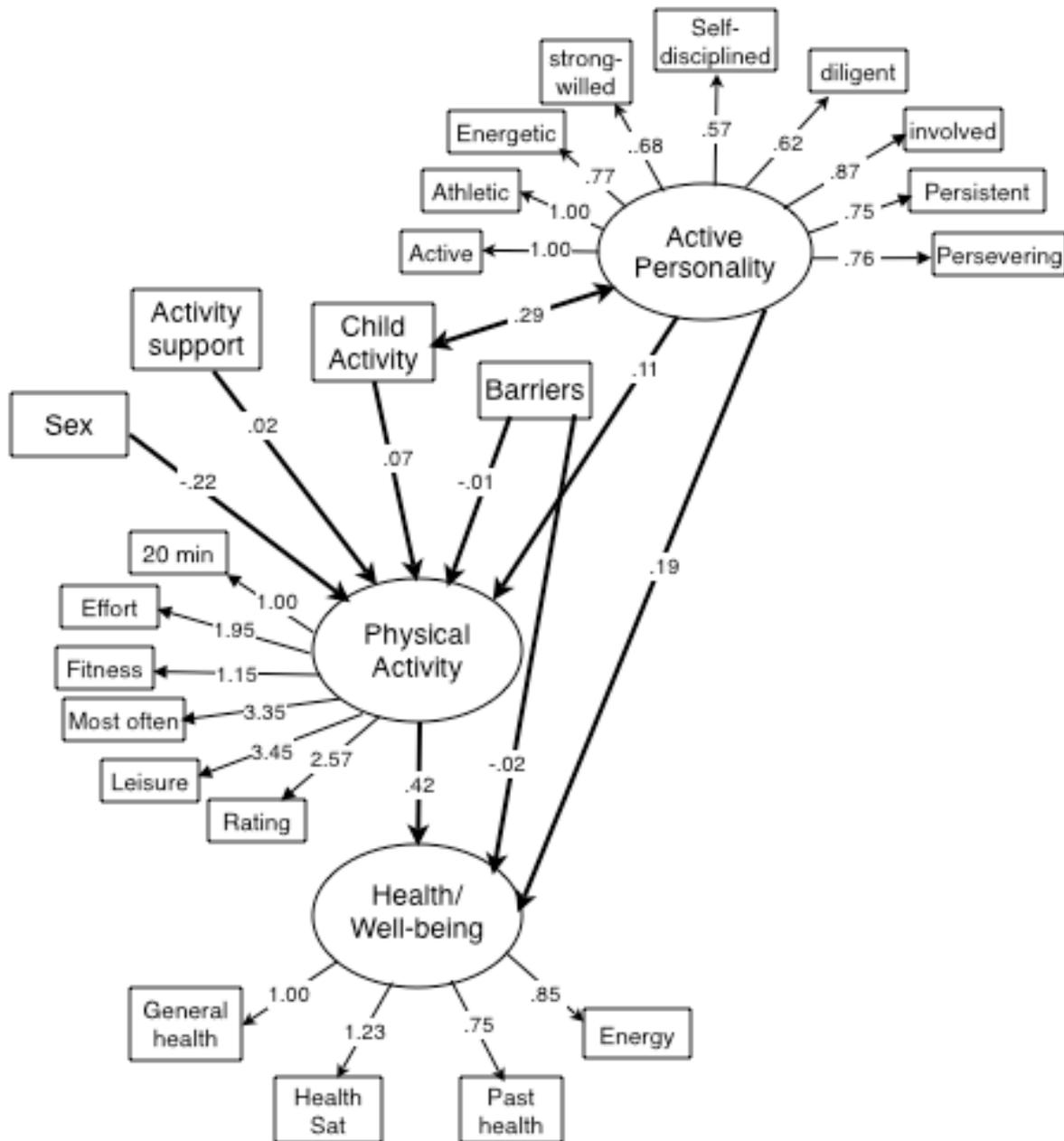




**Figure 6**  
SEM Conceptual Model



**Figure 7**  
*Final Estimated SEM Model*



*Note:* Path numbers are based on variance/covariances (non-standardized values) and error variances were estimated but for simplicity are not included in the drawing. Only significant pathways are shown. Model RMSEA = .10 (95% confidence interval = .09, .11).

## Appendix 1

### *The Terman archives at Stanford University*



The Psychology Building at Stanford: Home of the original Terman archives



Most of the data is stored in the fifth floor attic (complete with rat traps).



The files are stored in old, yet very sturdy wooden file cabinets.



Terman's bust watches over the files. The bust was designed and crafted by one of the Termites as a tribute to Terman's work and research.



The rest of the data is stored in the basement (behind the cabinets on the left). This basement is where Zimbardo's prison experiment was conducted.



Old files dating back to 1922.

## Appendix 2

*Terman qualitative data coding scheme, with assigned MET values.*

| <b>Code</b> | <b>Category</b>         | <b>Sample Alternative Activities</b>         | <b>MET value</b> |
|-------------|-------------------------|--|------------------|
| 0           | none                    | none listed; none in particular              | 0.00             |
| 1           | outdoor sports          | general outdoor recreation; outdoor activity | 6.25             |
| 2           | hiking                  | Hiking club; walking around desert           | 6.00             |
| 3           | mountaineering          | mountain hiking                              | 7.00             |
| 4           | mountain climbing       | rock climbing                                | 9.00             |
| 5           | backpacking             | pack trips                                   | 7.00             |
| 6           | camping                 |  | 2.50             |
| 7           | mountain biking         |  | 8.50             |
| 8           | nature appreciation     | Picnics; bird watching                       | 2.30             |
| 9           | country life            | country town living                          | 2.30             |
| 10          | forestry                | National park work                           | 8.00             |
| 11          | naturalists groups      | Sierra club; Audobon society                 | 3.00             |
| 12          | conservation efforts    | sail conservation techniques                 | 3.00             |
| 13          | fishing                 | fly casting; trout fishing                   | 3.25             |
| 14          | hunting (general)       | duck hunting; hunting club                   | 4.80             |
| 15          | hunting (large animals) | deer   | 6.00             |
| 16          | archery                 | archery club                                 | 3.50             |
| 17          | shooting                | Ballistics; Pistols; rifles                  | 2.50             |
| 18          | field trials            | dog field trials                             | 2.00             |
| 19          | sports (general)        | Athletics, recreation; intramural sports     | 6.00             |
| 20          | athletic clubs          | athletic association; Olympic club           | 4.00             |
| 21          | sports managing         | coaching; teaching sports classes            | 4.00             |
| 22          | badminton               |  | 4.50             |
| 23          | baseball                | Softball; cricket                            | 5.00             |
| 24          | basketball              | basketball team                              | 7.00             |
| 25          | biking                  | biking trips abroad                          | 8.00             |
| 26          | bowling                 | bowling league                               | 3.00             |
| 27          | cross country skiing    |  | 9.00             |
| 28          | curling                 |  | 4.00             |
| 29          | diving                  | dive team                                    | 3.00             |
| 30          | drill team              | yell leader                                  | 3.00             |
| 31          | fencing                 | fencing squad                                | 6.00             |
| 32          | figths                  | Boxing; wrestling                            | 8.00             |
| 33          | football                | football team; touch football                | 8.50             |
| 34          | golf                    | golf team                                    | 4.50             |
| 35          | gym work                | gym team; weight lifting                     | 6.00             |
| 36          | handball                |  | 12.00            |
| 37          | hockey                  | field hockey; ice hockey                     | 8.00             |
| 38          | horseshoe pitching      |  | 3.00             |
| 39          | jogging                 |  | 7.00             |
| 40          | lacrosse                |  | 8.00             |
| 41          | ping pong               | table tennis                                 | 4.00             |
| 42          | polo                    |  | 8.00             |
| 43          | racquetball             |  | 7.00             |
| 44          | rugby                   |  | 10.00            |
| 45          | running                 | cross-country; marathon running              | 9.50             |
| 46          | skating                 | figure skating; roller skating, ice skating  | 7.20             |
| 47          | skiing                  | Ski club, ski patrol                         | 7.00             |

| <b>Code</b> | <b>Category</b>           | <b>Sample Alternative Activities</b>         | <b>MET value</b> |
|-------------|---------------------------|--|------------------|
| 48          | soccer                    |  | 7.00             |
| 49          | squash                    |  | 12.00            |
| 50          | tennis                    | tennis club; tennis team                     | 7.00             |
| 51          | track and field           | track meets                                  | 6.00             |
| 52          | volleyball                | volleyball team                              | 4.00             |
| 53          | walking                   | walking for exercise                         | 3.80             |
| 54          | winter sports             |  | 6.25             |
| 55          | team captain              | coxswain                                     | 3.50             |
| 56          | timekeeping               |  | 1.80             |
| 57          | sports officiating        | refereeing                                   | 5.50             |
| 58          | Sports spectator          | event spectator; watching sports             | 1.50             |
| 59          | water sports              | Aquatics; snorkeling; surfing                | 6.00             |
| 60          | swimming                  | swim club; swim team                         | 8.50             |
| 61          | skin diving               | deep sea diving; scuba diving                | 7.00             |
| 62          | rowing                    | Crew; sculling; outrigger club               | 7.00             |
| 63          | water polo                |  | 10.00            |
| 64          | water skiing              |  | 6.00             |
| 65          | boating                   | Cruising; motor boating; sailing; yachting   | 3.00             |
| 66          | boat racing               | sailboat racing                              | 5.00             |
| 67          | boating clubs             | beach club; yacht club; sea scouts           | 3.00             |
| 68          | canoeing                  | kayaking                                     | 5.00             |
| 69          | horsemanship              | Equestrianism; horseback riding              | 4.00             |
| 70          | Training horses           | horse care                                   | 4.00             |
| 71          | horse racing              | horse jumping                                | 6.00             |
| 72          | horse shows               | showing horses                               | 3.00             |
| 73          | training/raising animals  | Cats; dogs; playing with pets                | 2.80             |
| 74          | animal breeding           | dog breeding                                 | 2.40             |
| 75          | raising small animals     | Owning pets; fish; apiary; beakeeping        | 2.25             |
| 76          | ranch operation           | cattle ranch; cowboy                         | 5.00             |
| 77          | farming                   | Agriculture; orange ranching                 | 4.25             |
| 78          | house development/ repair | building home; painting/papering house       | 4.25             |
| 79          | felling trees             | clearing land                                | 6.00             |
| 80          | cutting wood              | chopping wood                                | 6.00             |
| 81          | plumbing                  | Welding; wiring                              | 3.20             |
| 82          | carpentry                 | cabinet work; furniture making; tile setting | 4.20             |
| 83          | wood work                 | Wood carving; woodshop                       | 4.25             |
| 84          | work shop                 | drill press; hand tools; lathe work          | 3.00             |
| 85          | masonry                   | brick & stone construction; construction     | 7.00             |
| 86          | household                 | caring for house; cleaning; housework        | 3.20             |
| 87          | cooking                   | Baking; trying new recipes                   | 2.50             |
| 88          | interior decorating       | decorating church                            | 2.00             |
| 89          | family activity           | family activity with children; marriage      | 3.40             |
| 90          | gardening                 | Floriculture; horticulture                   | 4.00             |
| 91          | yard work                 | hedge pruning; landscaping                   | 4.50             |
| 92          | Design                    | architecture; dress design; stenography      | 2.80             |
| 93          | handcrafts                | Art; knitting; crafts; embroidery            | 1.70             |
| 94          | active craftwork          | Dress making; leather work; rug weaving      | 3.00             |
| 95          | sculpting                 | block painting; ceramics; glass blowing      | 3.50             |
| 96          | collections               | Book collecting; coin collecting; philately  | 1.50             |
| 97          | active collections        | Animal/ shell collecting; treasure hunting   | 2.50             |
| 98          | photography               | camera club; darkroom work                   | 2.00             |
| 99          | cinematography            | amateur movies; films; motion pictures       | 2.15             |

| <b>Code</b> | <b>Category</b>              | <b>Sample Alternative Activities</b>          | <b>MET value</b> |
|-------------|------------------------------|---|------------------|
| 100         | mechanics                    | Electronics; gadgetry; amateur radio          | 2.15             |
| 101         | Experiments                  | Electrical lab; chemical experiments          | 1.80             |
| 102         | modeling                     | model airplanes; model railroad               | 2.00             |
| 103         | applied design               | Block printing; engraving; gun smithing       | 2.20             |
| 104         | automobile work              | auto mechanics; auto repair                   | 3.50             |
| 105         | transport construction       | aircraft construction; boat building          | 3.80             |
| 106         | domestic travel              | sightseeing; exploring new places             | 2.00             |
| 107         | driving/motoring             | desert exploration; motorcycling              | 2.15             |
| 108         | foreign travel               | living abroad; study abroad                   | 2.00             |
| 109         | gliding                      | soaring                                       | 3.50             |
| 110         | aviation                     | aerial photography; flying                    | 2.00             |
| 111         | navigation                   |   | 1.65             |
| 112         | military training            | army activities; ROTC                         | 10.30            |
| 113         | civilian defense             | coast guard; national guard; state guard      | 5.00             |
| 114         | military associations        | Air force association; naval club; reserves   | 4.00             |
| 115         | dance                        | ballroom dancing; folk dancing                | 4.50             |
| 116         | square dancing               | tap dancing                                   | 4.50             |
| 117         | square dance calling         |   | 3.00             |
| 118         | modern dancing               | aesthetic dance; lap dancing; latino dancing  | 4.80             |
| 119         | teaching body movement       | Teaching dance; teaching acting               | 6.00             |
| 120         | acrobatics                   | Baton; gymnastics; tumbling                   | 4.00             |
| 121         | dance associations           | dance assembly; dance club                    | 3.25             |
| 122         | acting                       | amateur drama; class plays; marionettes       | 3.00             |
| 123         | play reading                 | reading for departments                       | 1.50             |
| 124         | stage work                   | stage construction; stage crew; stagecraft    | 3.20             |
| 125         | directing                    | Conducting; screen director                   | 2.70             |
| 126         | stage management             | Little theater manager, staff                 | 2.75             |
| 127         | theater                      | college theater; drama; foreign drama         | 2.70             |
| 128         | theater association          | actors guild; drama club; Little theater      | 2.00             |
| 129         | singing/ music               | Choir; glee club; voice                       | 2.00             |
| 130         | drum major                   | marching band                                 | 3.50             |
| 131         | percussion instruments       | drums   | 4.00             |
| 132         | guitar-type instruments      | Banjo; fiddle; guitar; violin                 | 2.50             |
| 133         | woodwind instruments         | Clarinet; flute; saxophone; oboe              | 2.00             |
| 134         | horn instruments             | Bagpipe; bassoon; trumpet; trombone; tuba     | 2.70             |
| 135         | string instruments (playing) | Accordion; cello; chamber music; piano        | 2.40             |
| 136         | making instruments           |   | 2.00             |
| 137         | song-writing                 | Arranging; composing; playwriting             | 1.80             |
| 138         | musical association          | acoustical society; piano club; music circle  | 1.80             |
| 139         | attending events             | art galleries; concerts; going to plays       | 1.50             |
| 140         | conferences/events           | Homecoming; senior ball                       | 2.00             |
| 141         | social activities            | alumni activities; church; club work          | 1.80             |
| 143         | games                        | Bridge; checkers; cards; poker                | 1.60             |
| 144         | billiards                    | pool  | 2.50             |
| 142         | socializing                  | breakfast club; dating; drinking; friends     | 1.60             |
| 145         | discussions                  | Conversation; debate great books club         | 1.80             |
| 146         | public speaking              | Lecturing; oratory; speaking; toastmasters    | 2.00             |
| 147         | political activity           | Civic affairs; lobbying; rallies; petitioning | 2.00             |
| 148         | politics                     | Unions; judicial affairs; public relations    | 1.50             |
| 149         | Study                        | Science; law; languages; history              | 1.80             |
| 150         | school work                  | continuing education classes                  | 1.80             |
| 151         | thinking                     | cross-word puzzles; numerology; logic         | 1.50             |

| <b>Code</b> | <b>Category</b>           | <b>Sample Alternative Activities</b>       | <b>MET value</b> |
|-------------|---------------------------|--|------------------|
| 152         | work                      | earning a living; occupation               | 3.00             |
| 153         | paper route               |  | 4.25             |
| 154         | waiting on tables         | cafeteria work; office clerk               | 2.80             |
| 155         | fire fighter              | fire department                            | 12.00            |
| 156         | janitor                   | custodial work                             | 3.50             |
| 157         | salesmanship              | auto sales; family business; real estate   | 2.00             |
| 158         | business                  | Accounting; finances; economics            | 1.50             |
| 159         | business groups           | accounting association; cooperatives       | 1.50             |
| 160         | journalism                | Editing; new writing; reporter; yearbook   | 1.75             |
| 161         | writing                   | Essays; poetry; short story writing        | 1.70             |
| 162         | typing                    | law clerk; office work; typology           | 1.50             |
| 163         | reading                   | Biographies; books; fiction; periodicals   | 1.40             |
| 164         | sleeping                  |  | 0.90             |
| 165         | rest                      | beach bumming; listening to music; loafing | 1.00             |
| 166         | personal self-improvement | nutrition                                  | 1.50             |
| 167         | teaching                  | child guidance; Sunday school; tutoring    | 2.60             |
| 168         | young peoples work        | Day care work; school programs             | 3.00             |
| 169         | scouts                    | boy scouts; girl scouts; YMCA; campfire    | 2.50             |
| 170         | helping others            | caring for ill family/friends              | 2.30             |
| 171         | medical aid               | blood bank; grey lady; VA hospital         | 2.75             |
| 172         | first aid instructing     | blood donations; first aid                 | 2.00             |
| 173         | community service         | Charity program; church work; social work  | 2.70             |
| 174         | ushering                  | usher at plays; gate captain               | 2.70             |
| 175         | church pastor             | church elder; church leadership; deacon    | 2.20             |
| 176         | religious groups          | Bible clubs; church guild                  | 1.60             |
| 177         | women's clubs             | AAUW; associated women students            | 1.60             |
| 178         | Interest clubs            | Club work; garden club; stamp society      | 1.70             |
| 179         | leadership                | Advisor; chair; director; manager          | 1.80             |
| 180         | committee work            | advisory board; booster club; PTA          | 1.80             |
| 181         | scholarly groups          | alumni group; literary club                | 1.40             |
| 182         | professional groups       | Employees Association; Greek societies     | 1.40             |

### Appendix 3

*Terman Study items representing older age health (assessed in 1986).*

| Scale                                       | Item   |
|---|--|
| Physical Health<br>( $\alpha = .75$ )       | <p>In general, my health has been good over the past few years</p> <p>I have an adequate energy/vitality level at this period of my life for a full range of activities</p> <p>I have cancer (R)</p> <p>I have a chronic heart condition (R)</p> <p>I have had several illnesses over the past few years (R)</p> <p>As I look back over my life, excellent health has contributed to my life accomplishments</p> <p>I have recently been troubled by declining health (R)</p> <p>I have recently been troubled by declining muscular strength or control (R)</p> <p>I have recently been troubled by not having enough personal energy</p> <p>I can complete daily tasks with little or no assistance</p>  |
| Subjective Well-Being<br>( $\alpha = .71$ ) | <p>Over the past few months, I have generally been in a positive mood</p> <p>Over the past few months, I have generally felt fairly calm or relaxed</p> <p>Taking things altogether, I would describe myself as pretty happy</p> <p>In the last few years, several disappointments or failures have exerted an influence on me (R)</p> <p>I am concerned about my mental health declining (R)</p> <p>Several aspects of my health give me cause to worry about my well being over the next few years (R)</p> <p>I am satisfied with my current living situation</p> <p>I am satisfied with my interactions with others</p> <p>I am satisfied with the quality and availability of my health care</p> <p>In looking back over my life, I am satisfied with the choices I made</p>   |
| Social Competence<br>( $\alpha = .71$ )     | <p>A goal or purpose of my life is to enjoy intimacy with others</p> <p>A goal or purpose in my life is to have many pleasant relationships</p> <p>I attend meetings of social groups or clubs</p> <p>I do community service with organizations</p> <p>I help others (friends, neighbors, children)</p> <p>I informally visit friends, neighbors, children</p> <p>I often interact with others on a close, personal basis</p> <p>As I look back over my life, good social adjustment has contributed to my life accomplishments</p>  |
| Productivity<br>( $\alpha = .72$ )          | <p>A goal or purpose of my life is to continue to grow personally, be creative, and productive</p> <p>A goal or purpose of my life is to continue to work</p> <p>A goal or purpose of my life is to continue to have opportunities for achievement or competition</p> <p>A goal or purpose of my life is to continue to produce social change</p> <p>A goal or purpose of my life is to make a contribution to society</p> <p>I continue to pursue educational opportunities or increase my knowledge &amp; skill</p> <p>Over the past few years, I have received special honors or awards</p> <p>I consider myself more ambitious or aspiring than my friends and colleagues in regard to excellence in whatever project I now engage in</p> <p>As I look back over my life, persistence in working toward a goal has contributed to my life accomplishments</p> <p>I continue to work part-time or full-time for pay</p> |

## Appendix 4

### The PHAB Survey (in print form)

**The PHAB Survey**

**1. Welcome!**

Thank you for agreeing to complete this survey. The following pages will ask questions about your health, lifestyle, personality, and more. Please read the instructions for each section carefully, and answer the questions to the best of your ability. There are no right or wrong answers, and your answers are completely anonymous and confidential. Completing the questions is voluntary, and you may choose not to answer any of the questions. However, we appreciate your full and honest responses, as much as possible.

**2. Physical Health**

First, we'd like to know a bit about your current health and your medical history. Remember, all answers are completely anonymous and confidential, and you can choose to not answer any questions that make you feel uncomfortable.

**Compared to others of your same age and sex, how is your health?**

Very poor     Poor     Fair     Good     Very good

**Compared to five years ago, how would you rate your health now?**

Much worse     Somewhat worse     About the same     Somewhat better     Much better

**How would you describe your energy and vitality at this period of life? (check one)**

Vigorous - I have considerable endurance     I have to limit myself somewhat

Adequate for a full program of activities     Lack of energy very much limits my activities

**How satisfied are you with your current physical health?**

Very dissatisfied     Dissatisfied     Neutral     Satisfied     Very satisfied

**During the past 4 weeks, how much did your health interfere with your normal activities?**

Not at all     Somewhat     Moderately     Quite a bit     Very much

**Do you currently have any medical conditions or chronic illnesses?**

No     Yes, under treatment     Yes, but not being treated

If yes, what condition(s)?

**The PHAB Survey**

**Has a doctor ever told you that you have or had any of the following conditions?**

|                          | No                    | Yes, but not treated  | Yes, treated in the past | Yes, currently being treated |
|--------------------------|-----------------------|-----------------------|--------------------------|------------------------------|
| Asthma                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Allergies/hay fever      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Arthritis                | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Heart attack             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Heart disease            | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Stroke                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Thyroid disease          | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| High blood pressure      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| High cholesterol         | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Migraine headaches       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Chronic fatigue syndrome | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Diabetes                 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |
| Cancer                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>    | <input type="radio"/>        |

Remarks or comments

**How often do you suffer physical pain?**

Never     Rarely     Occasionally     Often     Very often     Constantly

If you experience pain, briefly describe (e.g., where does it hurt, what does it feel like)?

**During the past 4 weeks, how much has physical pain interfere with your normal activities?**

Not at all     Somewhat     Moderately     Quite a bit     Very much

**How often do you take medication to function in your daily life? (Select one. Include prescription and over-the-counter drugs, but do not include vitamins or supplements)**

If you take medication regularly, what do you take and why?

**In the past year, how many times have you used medical services (primary care physician, urgent care, hospital, emergency room, local health care center, student health center, etc.)?**

### The PHAB Survey

**If you used medical services (in the past year), what did you use and why?**

**In the past year, how often have you used alternative forms of health care (for example, chiropractic, massage, acupuncture, psychotherapy, yoga)?**  
 None  1-2 times  3-5 times  6-10 times  Monthly  Weekly  Daily

If so, what did (do) you use and why?

**How satisfied are you with your access to health services?**  
 Very dissatisfied  Dissatisfied  Neutral  Satisfied  Very satisfied

**Was there a time during the last 12 months when you needed to see a doctor, but could not because of the cost or insurance issues?**  
 No  Yes  Don't remember

**Was there a time during the last 12 months when you needed medication, but could not get it because of the cost or insurance issues?**  
 No  Yes  Don't remember

**How healthy is your physical environment (e.g., pollution, climate, noise)?**  
 Very unhealthy  Somewhat unhealthy  Neutral  Somewhat healthy  Very healthy

**When you were a child, did you experience any of the following? (check all that apply)**

|   |  |
|---|--|
| <input type="checkbox"/> Born prematurely (4 or more weeks early) | <input type="checkbox"/> Raised by relatives                         |
| <input type="checkbox"/> Breast-fed as a baby                     | <input type="checkbox"/> Parents divorced before you were 21         |
| <input type="checkbox"/> Born a twin                              | <input type="checkbox"/> Either of your parents were in the military |
| <input type="checkbox"/> Adopted                                  | <input type="checkbox"/> Mother died before you were 21              |
| <input type="checkbox"/> In the foster care system                | <input type="checkbox"/> Father died before you were 21              |

**Did either of your biological parents have a heart attack before age 55?**

|        |                       |                       |                       |
|--------|-----------------------|-----------------------|-----------------------|
|        | No                    | Yes                   | Unknown               |
| Mother | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Father | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

### 3. Well-Being

The next few questions ask about your overall well-being and the stress you encounter in your daily life.

Page 3

### The PHAB Survey

**How would you rate your overall quality of life?**  
 Very poor  Poor  Fair  Good  Very good

**In general, how satisfied are you with your life?**  
 very dissatisfied  dissatisfied  neutral  satisfied  very satisfied

**Taking all things together, how would you describe yourself these days?**  
 Very unhappy  Somewhat unhappy  Neutral  Somewhat happy  Very happy

**For each of the following areas of life, indicate the overall level of satisfaction you have experienced.**

|   | Does not apply        | Not at all satisfying | Not very satisfying   | Somewhat satisfying   | Generally satisfying  | Highly satisfying     |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| School or educational activities        | <input type="radio"/> |
| Your work/occupation                    | <input type="radio"/> |
| Recognition for your accomplishments    | <input type="radio"/> |
| Your income                             | <input type="radio"/> |
| Your leisure time activities or hobbies | <input type="radio"/> |
| Your marriage                           | <input type="radio"/> |
| Your children                           | <input type="radio"/> |
| Friendships                             | <input type="radio"/> |
| Social contacts                         | <input type="radio"/> |
| Community service                       | <input type="radio"/> |
| Religion                                | <input type="radio"/> |

Other (please specify):

**Does your life offer satisfactory outlets for your mental capabilities?**  
 Yes  No

If not, please explain

**As compared to your friends or colleagues of the same sex and about the same age, how ambitious do you consider yourself in regard to the following?**

|                                   | Much more             | Somewhat more         | About the same        | Somewhat less         | Much less             |
|-----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Excellence in your work           | <input type="radio"/> |
| Recognition for your achievements | <input type="radio"/> |
| Vocational advancement            | <input type="radio"/> |
| Financial gain                    | <input type="radio"/> |

Page 4



### The PHAB Survey

**Life is sometimes difficult. Things happen for which we are unprepared and which can be difficult to handle. Have any of the following events happened to you?**

|  | Don't remember        | Within the past year  | 1-2 years ago         | 2-3 years ago         | 3-5 years ago         | More than 5 years ago | Never                 |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| You suffered a serious illness, injury, or assault.                                    | <input type="radio"/> |
| A close relative or loved one suffered a serious injury, illness, or assault.          | <input type="radio"/> |
| Your parent, child, sibling, or spouse died.   | <input type="radio"/> |
| A close family friend or another relative died.  | <input type="radio"/> |
| You separated or divorced due to marital difficulties.                                 | <input type="radio"/> |
| You broke off a steady relationship.   | <input type="radio"/> |
| You had a serious problem with a close friend, co-worker, boss, neighbor, or relative. | <input type="radio"/> |
| You lost your job.   | <input type="radio"/> |
| You had major financial problems.  | <input type="radio"/> |
| You had problems with the police or had to appear in court.                            | <input type="radio"/> |
| Something you valued was lost or stolen.   | <input type="radio"/> |

#### 4. Occupation & Leisure Time

Now we'd like to know a bit about what you do and how you use your time - both when you are working, and in your leisure time.

**What is your occupation? Please write your job title and briefly describe the work you do (list student, homemaker, or retired if this describes you). Indicate amount of time, if less than full time. If you work multiple jobs (or you are a student and also work for pay), please list each job and description separately.**

#1

#2

#3

#4

#5

**What was the total income for your household this past year? (select one)**

Page 7

### The PHAB Survey

**On a typical day, when you are at work (or school, if you are a full-time student), about how much time do spend doing each of the following?**

|                                  | Less than 30 minutes  | 30-60 minutes         | 1 to 3 hours          | 3 to 5 hours          | More than 5 hours     |
|----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Sitting                          | <input type="radio"/> |
| Standing                         | <input type="radio"/> |
| Walking                          | <input type="radio"/> |
| Lifting or carrying heavy things | <input type="radio"/> |
| Other strenuous tasks            | <input type="radio"/> |

If other, please specify what you do

**To what extent do you multi-task (do multiple activities at the same time)?**

Not at all     Somewhat     Moderately     Often     All the time

If you do multi-task, what activities do you typically do at the same time?

**How do you typically get around? (Check all that apply)**

Automobile     Motorcycle     Walk

SUV/ minivan     Bus     Bike

Pickup truck     Train/metroink     Skateboard/blades

Carpool van     Free local shuttle

Other (please specify):

**Do you commute to work or school?**

No     Yes

If yes, on average how much time (total) do you spend commuting each day?

**How much are you able to relax and enjoy yourself?**

Not at all     Somewhat     Moderately     Mostly     Completely

**How often do you do leisure activities?**

Never     Rarely     Occasionally     Often     Quite often     Weekly     Daily

Page 8

### The PHAB Survey

**What do you do in your leisure time? Think about all of the hobbies and leisure-time activities that you have do, including exercise and non-exercise activities (that is, any time when you are not working or studying).**

**Thinking about the activities and hobbies that you do, what activities do you do most often?**

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

**For these activities that you do most often, how hard do you typically work?**

Select your effort level

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8

Comments

Page 9

### The PHAB Survey

**On a typical day (including both work and non-work time), how much time do you spend on each of the following activities?**

|  | None                  | Less than 30 minutes  | 30 to 60 minutes      | 1 to 3 hours          | 3 to 5 hours          | More than 5 hours     |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Sleeping   | <input type="radio"/> |
| Watching TV or videos                                  | <input type="radio"/> |
| Talking on the telephone                               | <input type="radio"/> |
| Reading  | <input type="radio"/> |
| Using a computer                                       | <input type="radio"/> |
| Education, increasing knowledge or skills              | <input type="radio"/> |
| Volunteer/community work                               | <input type="radio"/> |
| Crafts or hobbies                                      | <input type="radio"/> |
| Sports or active recreation                            | <input type="radio"/> |
| Competitive activities                                 | <input type="radio"/> |
| Physical self-improvement (diet, exercise)             | <input type="radio"/> |
| Going to concerts, plays, lectures, etc.               | <input type="radio"/> |
| Serious practice of the arts (e.g., singing, painting) | <input type="radio"/> |
| Meetings of social groups or clubs                     | <input type="radio"/> |
| Communicating with relatives, friends, & neighbors     | <input type="radio"/> |
| Visiting with relatives, friends, & neighbors          | <input type="radio"/> |
| Helping others (friends, relatives, neighbors, etc.)   | <input type="radio"/> |
| Other (please specify)                                 | <input type="radio"/> |

If other, please specify what you do:

**List any clubs, organizations, or institutions to which you commit a substantial amount of time or interest.**

**Outside of work, do you do any service activities (such as scout work, welfare or church work, community and civic affairs, etc.)?**

None
  Rarely
  Occasionally
  Often
  Very often

If so, please describe.

### 5. Physical Activity

Page 10

### The PHAB Survey

**During a usual week, how often do you do physical exercise for at least 20 minutes without stopping? (please select)**

**Compared to others of your same age and sex,**

|                       | Much less             | Somewhat less         | About the same        | Somewhat more         | Much more             |
|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| How active are you?   | <input type="radio"/> |
| How fit are you?      | <input type="radio"/> |
| How flexible are you? | <input type="radio"/> |
| How strong are you?   | <input type="radio"/> |

**Do you have to limit your physical activity because of an illness, injury, or handicap?**

No  Yes

If yes, please specify why you must limit yourself:

**How does your current activity level compare to other periods of your life?**

Much less active  Somewhat less  About the same  Somewhat more  Much more active

**Have you had periods of your life when you engaged in no exercise and were physically quite inactive (like a "couch potato")? Check all that apply.**

|  |  |
|--|--|
| <input type="checkbox"/> No - I have always been pretty active | <input type="checkbox"/> More than 5 years ago |
| <input type="checkbox"/> Before age 12                         | <input type="checkbox"/> 3 to 5 years ago      |
| <input type="checkbox"/> Age 12-18                             | <input type="checkbox"/> 1 to 2 years ago      |
| <input type="checkbox"/> Early adulthood (18-23)               | <input type="checkbox"/> Within the last year  |
| <input type="checkbox"/> In my 20s                             | <input type="checkbox"/> Currently inactive    |

**Were you ever injured while exercising or playing a sport so that you had to limit your physical activity for a month or more?**

|                              | Yes                   | No                    | Don't remember        |
|------------------------------|-----------------------|-----------------------|-----------------------|
| As a child                   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| As an adolescent (age 12-18) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| As an adult                  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

**When you were an adolescent (age 12-18), how active were you compared to others of your same age and sex?**

Much less active  Somewhat less  About the same  Somewhat more  Much more active

Page 11

### The PHAB Survey

**What special activities or hobbies did you participate in during high school? Note any honors received (e.g., societies, athletic letters, etc.)**

**What special activities or hobbies did you participate in during college? Note any honors received (e.g., societies, athletic letters, etc.)**

**For each of the following periods of your life, to what extent did you enjoy physical education classes?**

|                   | NA - no classes offered or did not take | Completely disliked the classes | Somewhat disliked the classes | Liked some activities & disliked others | Somewhat liked the classes | Completely liked the classes |
|-------------------|---|---------------------------------|-------------------------------|---|----------------------------|------------------------------|
| Elementary school | <input type="radio"/>                   | <input type="radio"/>           | <input type="radio"/>         | <input type="radio"/>                   | <input type="radio"/>      | <input type="radio"/>        |
| Middle school     | <input type="radio"/>                   | <input type="radio"/>           | <input type="radio"/>         | <input type="radio"/>                   | <input type="radio"/>      | <input type="radio"/>        |
| High school       | <input type="radio"/>                   | <input type="radio"/>           | <input type="radio"/>         | <input type="radio"/>                   | <input type="radio"/>      | <input type="radio"/>        |
| College           | <input type="radio"/>                   | <input type="radio"/>           | <input type="radio"/>         | <input type="radio"/>                   | <input type="radio"/>      | <input type="radio"/>        |

Remarks/comments

**When you were growing up, how often were you forced to exercise or play sports?**

Never  Occasionally  Sometimes  Quite a bit  Very often

If so, who forced you?

**Not counting yourself, are there any adults in your household who exercise at least 3 times a week for 20 minutes or more?**

No  Yes

If yes, who is that person (e.g., significant other, roommate, etc.)

**Over the past 3 months, how often did your family or friends do the following?**

|  | Never                 | Once or twice         | Occasionally          | Often                 | Very often            |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Exercised with me                              | <input type="radio"/> |
| Offered to exercise with me                    | <input type="radio"/> |
| Encouraged me to exercise                      | <input type="radio"/> |
| Made fun of me or criticized me for exercising | <input type="radio"/> |
| Told me not to exercise                        | <input type="radio"/> |

Page 12

### The PHAB Survey

**How often do you see people walking, jogging, running, or biking in your neighborhood?**

Never   
  Occasionally   
  Quite a bit   
  Very often   
  All the time

**To what extent do you feel you live in a safe and secure environment?**

Not at all   
  Somewhat   
  Moderately   
  Quite a bit   
  Very much

**Are there any exercise programs or facilities where you work?**

N/A   
  No   
  Yes

If yes, do you use them?

**Think about how much you walk in a typical week. For each of the following, select how much time you spend walking and what your normal pace is (if applicable).**

|   | Time spent walking   | Normal pace          |
|---|----------------------|----------------------|
| Walking to and from work or school                  | <input type="text"/> | <input type="text"/> |
| Walking during breaks and lunch time                | <input type="text"/> | <input type="text"/> |
| Walking as part of errands for work                 | <input type="text"/> | <input type="text"/> |
| Walking as part of errands for home or personal use | <input type="text"/> | <input type="text"/> |
| Walking with a pet                                  | <input type="text"/> | <input type="text"/> |
| Walking for exercise                                | <input type="text"/> | <input type="text"/> |
| Walking with another person                         | <input type="text"/> | <input type="text"/> |
| Hiking  | <input type="text"/> | <input type="text"/> |

If you do walk, where do you usually walk (e.g., on campus, local park, sidewalk near house, hiking trail)?

**Where do you usually exercise? (check all that apply)**

None - I do not exercise   
  School facility   
  Commercial or private club  
 In my home   
  Church facility   
  Outside using no special facility  
 Local gym/fitness center   
  College/university facility   
  Free recreational center  
 At work   
  Local park  
 Other (please specify)

Page 13

### The PHAB Survey

**When you think about participating in exercise or physical activity, to what extent do you believe the following will result from that activity?**

|   | Strongly disagree     | Disagree              | Neutral               | Agree                 | Strongly agree        |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I will feel less depressed or anxious       | <input type="radio"/> |
| I will improve my self-esteem               | <input type="radio"/> |
| I will meet new people                      | <input type="radio"/> |
| I will improve my relationships with others | <input type="radio"/> |
| I will lose weight                          | <input type="radio"/> |
| I will look better                          | <input type="radio"/> |
| I will build muscle strength                | <input type="radio"/> |
| I will feel less tension and stress         | <input type="radio"/> |
| I will improve my health                    | <input type="radio"/> |
| I will reduce my risk of illness            | <input type="radio"/> |
| I will do better at my job                  | <input type="radio"/> |
| I will feel more attractive                 | <input type="radio"/> |
| I will improve my heart and lung fitness    | <input type="radio"/> |

**How often do the following prevent you from exercising?**

|   | Never                 | Occasionally          | Often                 | Very often            | Always                |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Feeling self-conscious about how I look                   | <input type="radio"/> |
| Lack of interest in exercise                              | <input type="radio"/> |
| Lack of self-discipline                                   | <input type="radio"/> |
| Lack of time  | <input type="radio"/> |
| Lack of energy  | <input type="radio"/> |
| Lack of company   | <input type="radio"/> |
| Lack of enjoyment from exercise                           | <input type="radio"/> |
| Feeling discouraged                                       | <input type="radio"/> |
| Lack of equipment   | <input type="radio"/> |
| Bad weather   | <input type="radio"/> |
| Lack of skills  | <input type="radio"/> |
| No facilities or space                                    | <input type="radio"/> |
| Lack of child care  | <input type="radio"/> |
| Lack of knowledge on how to exercise or use the equipment | <input type="radio"/> |
| Health problems   | <input type="radio"/> |
| Fear of injury  | <input type="radio"/> |
| Injury  | <input type="radio"/> |
| Other reasons   | <input type="radio"/> |

If other, please specify:

**6. Other Health Behaviors**

Page 14

### The PHAB Survey

**How tall are you without shoes?**  
 feet   
 inches

**About how much do you currently weigh (without shoes)?**  
 Lbs

**Are you currently on a diet to try to lose or gain weight?**  
 Undecided     No     Yes, to lose weight     Yes, to gain weight

If yes, what plan are you following?

**How satisfied are you with the way your body looks?**  
 Very dissatisfied     Dissatisfied     Neutral     Satisfied     Very satisfied

**Do you follow a special diet or have special dietary concerns? (check all that apply and/or fill-in)**

Low fat     Dairy-free     Wheat-free  
 Low salt     Gluten-free     Vegetarian (specify type)  
 Diabetic/ low-sugar     Kosher     Vegan

Other (please specify):

**How many meals do you typically eat per day (not including snacks)?**  
 0     1     2     3     4     5 or more     varies daily

**How many snacks do you typically eat per day?**  
 0     1     2     3     4     5 or more     varies daily

**To what extent do the following statements characterize your eating habits?**

|                                  | Not at all            | Somewhat              | Moderately            | Fairly well           | Very well             |
|----------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| I eat whenever I feel hungry.    | <input type="radio"/> |
| I try to follow a balanced diet. | <input type="radio"/> |
| I eat between meals.             | <input type="radio"/> |

Page 15

### The PHAB Survey

**How often do you do the following?**

|   | Never                 | Rarely                | Occasionally          | Monthly               | Weekly                | Several times per week | Daily                 |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|------------------------|-----------------------|
| Eat at a fast-food restaurant               | <input type="radio"/>  | <input type="radio"/> |
| Eat at a sit-down restaurant                | <input type="radio"/>  | <input type="radio"/> |
| Cook food at home or eat a home-cooked meal | <input type="radio"/>  | <input type="radio"/> |
| Eat breakfast                               | <input type="radio"/>  | <input type="radio"/> |

**Think about the foods that you have eaten on a typical day over the past month. How often do you generally eat or drink each of the following?**

|                                 | not at all            | 1-3 times in the last month | Once per week         | 2-3 times per week    | 4-6 times per week    | Once per day          | 2 or more times per day |
|---------------------------------|-----------------------|-----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------|
| Beans/ legumes                  | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Candy                           | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Cheese                          | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Chicken/ turkey                 | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Coffee (with caffeine)          | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Diet soft drinks                | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Fish                            | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Fresh fruit or fruit juice      | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Fresh vegetables or salad       | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Fried food                      | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Frozen dinners                  | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Ham, spam, other luncheon meats | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Hamburgers/ cheeseburgers       | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| High fiber/ bran cereals        | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Ice cream (not low fat)         | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Macaroni, potato, or tuna salad | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |

Page 16

### The PHAB Survey

**Foods**

|  | not at all            | 1-3 times in the last month | Once per week         | 2-3 times per week    | 4-6 times per week    | Once per day          | 2 or more times per day |
|--|-----------------------|-----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------|
| Pasta  | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Pastries (doughnuts, cookies, cakes, pies, etc.) | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Potatoes   | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Potato/ corn chips                               | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Pizza  | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Rice   | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Salad dressing (not low fat)                     | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Salty snacks                                     | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Sausage, bacon, hot dogs                         | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Skim, 1%, or 2% milk                             | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Soda/ soft drinks (not diet)                     | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Soy products                                     | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Tea  | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Vitamin supplements                              | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Whole grain products                             | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Whole milk                                       | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |
| Other  | <input type="radio"/> | <input type="radio"/>       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>   |

Other (please specify)

**How many hours do you typically sleep at night? (fill in the number of hours)**

**To what extent do you have difficulties with falling asleep, waking up during the night, or waking up too early?**

Not at all     Somewhat     Moderately     Quite a bit     Very much

**In general, how would you rate the quality of your sleep?**

Very poor     Poor     Fair     Good     Very good

Page 17

### The PHAB Survey

**The following are different health behaviors that people often want to change to improve their health. For each one, select which statement best reflects your attitude on the behavior.**

Your attitude

Eat less food each day (decrease the number of calories you eat)

Cut down on the stress in my life

Decrease how much alcohol I drink

Eat more fiber (cereals, whole grain breads)

Cut down (or quitting) smoking

Decrease the amount of sweets I eat (candy, desserts)

Eat less red meat

Eat fewer carbohydrates

Do more physical exercise

Decrease fat in my diet

Get more sleep

Eat more fruits and vegetables

Drink less caffeine

Cut down on salt

Gamble less

Watch less television

Spend more time with family

Spend more time with friends

Spend more time outside

Remarks/Comments

**To what extent do you drink alcoholic beverages? (select)**

If you drink, what do you typically drink?

**A drink is one can or bottle of beer, one glass of wine, one can or bottle of wine cooler, one cocktail, or one shot of liquor.**

How many days in the past month did you drink an alcoholic beverage?

On the days you drank, about how many drinks did you consume?

How many times in the last 30 days did you have 5 or more drinks on a single occasion?

Page 18

### The PHAB Survey

**Have you smoked at least 100 cigarettes in your life (5 packs)?**

No  Yes

If yes, about how old were you when you first smoked?

**Have you ever been a regular smoker?**

No  Yes, in the past  Yes, currently

**How many times in the past 30 days have you done the following?**

Smoked cigarettes

Smoked cigars

Used any smokeless tobacco products (such as chewing tobacco or snuff?)

**Are you currently trying to quit smoking?**

Not applicable (not a smoker)

No, I am not trying to quit

No, I successfully quit in the past

Yes, I am currently trying to quit

---

### 7. Social Support and Relationships

The next few questions ask about your relationships with friends, family, and acquaintances.

**Not including yourself, how many people live in your household (including children)?**

**How many living siblings do you have?**

**Among your living siblings, with how many do you have each of the following relationships?**

Intimate: we share most of our joys & sorrows

Companionship: frequent interaction arising out of shared interests

Casual: we don't seek each other out

Indifferent/hostile: we actively avoid one another

**What is your current marital status? (select one)**

Other (please specify)

Page 19

### The PHAB Survey

**If you are married, how happy has your marriage been? (please select one)**

Comments

**If you live with a significant other, how happy has your relationship been? (select one).**

Comments

**Do you have any children? If so, please note how many. Of these, how many live at home?**

Biological

Adopted

Foster

Step-children

Other

# living at home?

**If you have children, how would you describe your relationships with them?**

**Have you ever experienced any of the following? (check yes or no)**

|   | Yes                   | No                    |
|---|-----------------------|-----------------------|
| Been legally married                          | <input type="radio"/> | <input type="radio"/> |
| Lived in a relationship as a domestic partner | <input type="radio"/> | <input type="radio"/> |
| Been widowed                                  | <input type="radio"/> | <input type="radio"/> |
| Been divorced                                 | <input type="radio"/> | <input type="radio"/> |
| Had biological children                       | <input type="radio"/> | <input type="radio"/> |
| Adopted children                              | <input type="radio"/> | <input type="radio"/> |

**Among the members of your immediate family & close relatives (e.g., children, siblings, parents, grandparents, aunts, uncles, nieces, nephews, etc.), with how many do you have each of the following relationships?**

Intimate: we share most of our joys & sorrows

Companionship: frequent interaction arising out of shared interests

Casual: we don't seek each other out

Indifference/ hostility: we actively avoid one another

**How satisfied are you with your relationships with your family members and close relatives?**

Very dissatisfied  Dissatisfied  Neutral  Satisfied  Very satisfied

Page 20

### The PHAB Survey

**Consider your 10 best friends (excluding family & close relatives). How many of them would you place in each of the following categories?**

Intimate: we share most of our joys & sorrows

Companionship: frequent interaction arising out of shared interests

Casual: we don't seek each other out

**How satisfied are you with your relationships with your friends?**

Very dissatisfied  Dissatisfied  Neutral  Satisfied  Very satisfied

**To what extent can you count on your friends or family members to be there when you need them?**

Not at all  Somewhat  Moderately  Mostly  Completely

**To what extent do you feel alone in life?**

Not at all  Somewhat  Moderately  Quite a bit  Very much

**Do you provide care or assistance that some friend or relative needs?**

no  yes

If yes, please describe:

**How satisfied are you with your ability to provide for or support others?**

Very dissatisfied  Dissatisfied  Neutral  Satisfied  Very satisfied

---

### 8. Personality

Page 21

### The PHAB Survey

**In each trait or characteristic below, compare yourself to others of the same age and gender. Read each of the options, and mark the column that best describes you, as a person.**

|  | This describes me completely | I'm well above average in this respect | I'm about average in this respect | I'm somewhat below average in this respect | This does not describe me at all |
|--|------------------------------|--|-----------------------------------|--|----------------------------------|
| Healthy                                | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| High physical energy                   | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Prudence & forethought                 | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Mechanical ingenuity                   | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Will power & perseverance              | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Desire to excel                        | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Desire to know                         | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Originality                            | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Impulsiveness                          | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Enjoyment of social contacts           | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Persistence in accomplishing your ends | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |
| Driven by a particular life purpose    | <input type="radio"/>        | <input type="radio"/>                  | <input type="radio"/>             | <input type="radio"/>                      | <input type="radio"/>            |

**Would you say the following describe you as a person or not?**

|  | Yes                   | No                    | Unsure                |
|--|-----------------------|-----------------------|-----------------------|
| You try to get your own way, even if you have to fight for it    | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| You often in a state of excitement                               | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| Discipline make you discontented                                 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| You are the "stay-at-home" rather than the "out-and-about" type? | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| You enjoy planning your work in detail                           | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| You usually drive yourself steadily in your work                 | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Page 22

### The PHAB Survey

**Please use the common human traits below to describe yourself. Describe yourself as you see yourself in the present, in relation to others you know of your age and sex (not how you'd like to be in the future).**

|                            | Very inaccurate       | Somewhat inaccurate   | Slightly inaccurate   | Neither               | Slightly accurate     | Somewhat accurate     | Very accurate         |
|----------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Achievement-oriented       | <input type="radio"/> |
| Active                     | <input type="radio"/> |
| Adaptable                  | <input type="radio"/> |
| Ambitious                  | <input type="radio"/> |
| Apathetic                  | <input type="radio"/> |
| Assertive                  | <input type="radio"/> |
| Athletic                   | <input type="radio"/> |
| Bashful                    | <input type="radio"/> |
| Bold                       | <input type="radio"/> |
| Careful of my belongings   | <input type="radio"/> |
| Careless                   | <input type="radio"/> |
| Cold                       | <input type="radio"/> |
| Complaining                | <input type="radio"/> |
| Complex                    | <input type="radio"/> |
| Concerned about acceptance | <input type="radio"/> |
| Conscientious              | <input type="radio"/> |
| Considerate                | <input type="radio"/> |

Page 23

### The PHAB Survey

...

|                        | Very inaccurate       | Somewhat inaccurate   | Slightly inaccurate   | Neither               | Slightly accurate     | Somewhat accurate     | Very accurate         |
|------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Cooperative            | <input type="radio"/> |
| Creative               | <input type="radio"/> |
| Curious                | <input type="radio"/> |
| Dedicated              | <input type="radio"/> |
| Deep                   | <input type="radio"/> |
| Determined             | <input type="radio"/> |
| Diligent               | <input type="radio"/> |
| Disorganized           | <input type="radio"/> |
| Driven                 | <input type="radio"/> |
| Eccentric              | <input type="radio"/> |
| Efficient              | <input type="radio"/> |
| Emotionally stable     | <input type="radio"/> |
| Energetic              | <input type="radio"/> |
| Enterprising           | <input type="radio"/> |
| Envious                | <input type="radio"/> |
| Esthetically sensitive | <input type="radio"/> |
| Extraverted            | <input type="radio"/> |
| Fearful                | <input type="radio"/> |
| Fickle                 | <input type="radio"/> |

Page 24

### The PHAB Survey

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|               | Very inaccurate       | Somewhat inaccurate   | Slightly inaccurate   | Neither               | Slightly accurate     | Somewhat accurate     | Very accurate         |
|---------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Fidgety       | <input type="radio"/> |
| Fretful       | <input type="radio"/> |
| Goal-oriented | <input type="radio"/> |
| Good-looking  | <input type="radio"/> |
| Gregarious    | <input type="radio"/> |
| Happy         | <input type="radio"/> |
| Hardy         | <input type="radio"/> |
| Harsh         | <input type="radio"/> |
| Idle          | <input type="radio"/> |
| Imaginative   | <input type="radio"/> |
| Impulsive     | <input type="radio"/> |
| Industrious   | <input type="radio"/> |
| Inefficient   | <input type="radio"/> |
| Innovative    | <input type="radio"/> |
| Intellectual  | <input type="radio"/> |
| Involved      | <input type="radio"/> |
| Irresponsible | <input type="radio"/> |
| Jealous       | <input type="radio"/> |
| Kind          | <input type="radio"/> |
| Knowledgeable | <input type="radio"/> |

Page 25

### The PHAB Survey

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|                    | Very inaccurate       | Somewhat inaccurate   | Slightly inaccurate   | Neither               | Slightly accurate     | Somewhat accurate     | Very accurate         |
|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Lazy               | <input type="radio"/> |
| Lethargic          | <input type="radio"/> |
| Mannerly           | <input type="radio"/> |
| Moody              | <input type="radio"/> |
| Neat in appearance | <input type="radio"/> |
| Nervous            | <input type="radio"/> |
| Obedient           | <input type="radio"/> |
| Organized          | <input type="radio"/> |
| Original           | <input type="radio"/> |
| Outspoken          | <input type="radio"/> |
| Perceptive         | <input type="radio"/> |
| Persevering        | <input type="radio"/> |
| Persistent         | <input type="radio"/> |
| Philosophical      | <input type="radio"/> |
| Planful            | <input type="radio"/> |
| Practical          | <input type="radio"/> |
| Productive         | <input type="radio"/> |
| Quiet              | <input type="radio"/> |
| Relaxed            | <input type="radio"/> |
| Resilient          | <input type="radio"/> |

Page 26

### The PHAB Survey

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|                    | Very inaccurate       | Somewhat inaccurate   | Slightly inaccurate   | Neither               | Slightly accurate     | Somewhat accurate     | Very accurate         |
|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Restless           | <input type="radio"/> |
| Rigid              | <input type="radio"/> |
| Rude               | <input type="radio"/> |
| Seclusive          | <input type="radio"/> |
| Self-centered      | <input type="radio"/> |
| Self-disciplined   | <input type="radio"/> |
| Self-reliant       | <input type="radio"/> |
| Sensible           | <input type="radio"/> |
| Shy                | <input type="radio"/> |
| Sleppy             | <input type="radio"/> |
| Socially confident | <input type="radio"/> |
| Spiteful           | <input type="radio"/> |
| Strong-willed      | <input type="radio"/> |
| Stubborn           | <input type="radio"/> |
| Submissive         | <input type="radio"/> |
| Suspicious         | <input type="radio"/> |
| Sympathetic        | <input type="radio"/> |
| Systematic         | <input type="radio"/> |

...

|                 | Very inaccurate       | Somewhat inaccurate   | Slightly inaccurate   | Neither               | Slightly accurate     | Somewhat accurate     | Very accurate         |
|-----------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Talkative       | <input type="radio"/> |
| Temperamental   | <input type="radio"/> |
| Tense           | <input type="radio"/> |
| Thoughtful      | <input type="radio"/> |
| Tireless        | <input type="radio"/> |
| Touchy          | <input type="radio"/> |
| Unattractive    | <input type="radio"/> |
| Uncreative      | <input type="radio"/> |
| Unenvious       | <input type="radio"/> |
| Unintellectual  | <input type="radio"/> |
| Unsympathetic   | <input type="radio"/> |
| Verbally fluent | <input type="radio"/> |
| Warm            | <input type="radio"/> |
| Withdrawn       | <input type="radio"/> |

Are there any other terms you'd use to describe yourself? If so, type them here.

Page 27

### The PHAB Survey

#### 9. Background Information

Finally, we'd like to get some basic background information, for statistical purposes. Remember that all responses are anonymous and confidential.

**How did you hear about this study?**

**What is your sex?**

Male  Female

**What is your current age?**

**Where were you born?**

City/Town:

State/Province:

Country:

**Where do you currently live?**

City/Town:

State/Province:

Country:

**What is the highest grade or year of school you have completed? (select one)**

**Have you ever served in the armed services, or in the state or national guard?**

Yes  No

If yes, please describe.

**What is your ethnicity (please type in how you identify yourself)?**

#### 10. Thank You!

That brings you to the end of the survey. Once you are happy with your responses, click the submit button below (only click this once). Once the survey goes through, a final page will conclude things.

Page 28

## Appendix 5

## Phab survey: question source

| Question   | Source          |
|--|-----------------|
| <b>Part 1: Physical Health</b>   |                 |
| Compared to others of your same age and sex, how is your health?   | Hampson, Terman |
| Compared to five years ago, how would you rate your health now?  | Hampson         |
| How would you describe your energy and vitality at this period of life?  | Terman          |
| How satisfied are you with your current physical health?   | WHO             |
| During the past 4 weeks, how much did your health interfere with your normal activities?   | Hampson         |
| Do you currently have any medical conditions or chronic illnesses?   | Other           |
| Has a <b>doctor</b> ever told you that you have or had any of the following conditions? (asthma; allergies/hay fever; arthritis; heart attack; heart disease; stroke; thyroid disease; high blood pressure; high cholesterol; migraine headaches; chronic fatigue syndrome; diabetes; cancer)  | Hampson         |
| How often do you suffer physical pain? If you experience pain, briefly describe (e.g., where does it hurt, what does it feel like)?  | WHO             |
| During the past 4 weeks, how much has physical pain interfere with your normal activities?   | Hampson         |
| How often do you take medication to function in your daily life? If you take medication regularly, what do you take and why?   | WHO             |
| In the past year, how many times have you used medical services (primary care physician, urgent care, hospital, emergency room, local health care center, student health center, etc.)?  | Hampson         |
| If you used medical services (in the past year), what did you use and why?   | Other           |
| In the past year, how often have you used alternative forms of health care (e.g., chiropractic, massage, acupuncture, psychotherapy, yoga)? If so, what did (do) you use and why?  | Hampson         |
| How satisfied are you with your access to health services?   | WHO, Terman     |
| Was there a time during the last 12 months when you needed to see a doctor, but could not because of the cost or insurance issues?   | Hampson         |
| Was there a time during the last 12 months when you needed medication, but could not get it because of the cost or insurance issues?   | Other           |
| How healthy is your physical environment (e.g., pollution, climate, noise)?  | WHO             |
| When you were a child, did you experience any of the following? <ul style="list-style-type: none"> <li>• Born prematurely</li> <li>• Breast-fed as a baby</li> <li>• Born a twin</li> <li>• Adopted</li> <li>• In the foster care system</li> <li>• Raised by relatives</li> <li>• Parents divorced before you were 21</li> <li>• Either of your parents were in the military</li> <li>• Mother died before you were 21</li> <li>• Father died before you were 21</li> </ul> | Hampson         |
| Did either of your biological parents have a heart attack before age 55?   | Sallis          |
| <b>Part 2: Well-being</b>  |                 |
| How would you rate your overall quality of life?   | WHO             |
| In general, how satisfied are you with your life?  | WHO             |
| Taking all things together, how would you describe yourself these days?  | Terman          |
| For each of the following areas of life, indicate the overall level of satisfaction you have experienced <ul style="list-style-type: none"> <li>• School or educational activities</li> <li>• Your work/occupation</li> <li>• Recognition for your accomplishments</li> <li>• Your income</li> <li>• Your leisure time activities or hobbies</li> <li>• Your marriage</li> <li>• Your children</li> <li>• Friendships</li> </ul>   | Terman          |

| Question   | Source                           |
|--|----------------------------------|
| <ul style="list-style-type: none"> <li>• Social contacts</li> <li>• Community service</li> <li>• Religion</li> </ul>   |                                  |
| Does your life offer satisfactory outlets for your mental capabilities?  | Terman                           |
| <p>As compared to your friends or colleagues of the same sex and about the same age, how ambitious do you consider yourself in regard to the following?</p> <ul style="list-style-type: none"> <li>• Excellence in your work</li> <li>• Recognition for your achievements</li> <li>• Vocational advancement</li> <li>• Financial gain</li> </ul>   | Terman                           |
| <p>As compared to others of the same age and gender, to what extent are you interested in succeeding at the following?</p> <ul style="list-style-type: none"> <li>• Competitive sports</li> <li>• Being a leader</li> <li>• Having friends</li> <li>• Making money</li> <li>• Being a social success</li> <li>• Work or schoolwork</li> </ul>  | Terman                           |
| On the whole, how well do you think you have lived up to your intellectual ability?  | Terman                           |
| Briefly describe your ultimate goals at this time.   | Terman                           |
| <p>Please indicate how much you agree with each of the following statements:</p> <ul style="list-style-type: none"> <li>• I have little control over the things that happen to me.</li> <li>• There is really no way I can solve some of the problems that I have.</li> <li>• I can do just about anything I really set my mind to do.</li> <li>• There is little I can do to change many of the important things in my life.</li> <li>• What happens to me in the future mostly depends on me.</li> <li>• I often feel helpless in dealing with the problems of life.</li> <li>• Sometimes I feel that I am being pushed around in life.</li> </ul>   | Locus of control scale - Hampson |
| <p>Over the past month, how often have you felt or behaved in the following ways?</p> <ul style="list-style-type: none"> <li>• Had trouble completing normal daily activities.</li> <li>• Had trouble completing your work.</li> <li>• Had trouble interacting with other people.</li> <li>• Become bothered by things that don't usually bother you.</li> <li>• Had a poor appetite.</li> <li>• Felt that you could not shake off the blues.</li> <li>• Felt that you were just as good as other people.</li> <li>• Felt depressed.</li> <li>• Felt that everything you did was an effort.</li> <li>• Felt hopeful about the future.</li> <li>• Thought that your life has been a failure.</li> <li>• Had trouble sleeping.</li> <li>• Felt happy.</li> </ul> | Depression scale – Hampson       |
| To what extent have you had a tendency toward nervousness, worry, special anxieties or nervous breakdown over the past few months? If so, please describe.   | Terman                           |
| In the last few years, have any disappointments, failures, deaths of friends or family, uncongenial relationships with others, etc. exerted an influence on you? Please describe.  | Terman                           |
| <p>Life is sometimes difficult. Things happen for which we are unprepared and which can be difficult to handle. Have any of the following events happened to you?</p> <ul style="list-style-type: none"> <li>• You suffered a serious illness, injury, or assault.</li> <li>• A close relative or loved one suffered a serious injury, illness, or assault.</li> <li>• Your parent, child, sibling, or spouse died.</li> <li>• A close family friend or another relative died.</li> <li>• You separated or divorced due to marital difficulties.</li> <li>• You broke off a steady relationship.</li> <li>• You had a serious problem with a close friend, co- worker, boss, neighbor, or relative.</li> <li>• You lost your job.</li> </ul>                   | Stressful life events - Hampson  |

| Question   | Source                        |
|--|-------------------------------|
| <ul style="list-style-type: none"> <li>You had major financial problems.</li> <li>You had problems with the police or had to appear in court.</li> <li>Something you valued was lost or stolen.</li> </ul>   |                               |
| <b>Part 3: Occupation &amp; Leisure Time</b>   |                               |
| What is your occupation? Please write your job title and briefly describe the work you do (list student, homemaker, or retired if this describes you). Indicate amount of time, if less than full time. If you work multiple jobs (or are a student and also work), please list each job and description separately.   | Terman                        |
| What was the total income for your household this past year?   | Sallis, Terman                |
| <p>On a typical day, when you are at work (or school, if you are a full-time student), about how much time do you spend doing each of the following?</p> <ul style="list-style-type: none"> <li>Sitting</li> <li>Standing</li> <li>Walking</li> <li>Lifting or carrying heavy things</li> <li>Other strenuous tasks (please specify)</li> </ul>  | Sallis                        |
| To what extent do you multi-task (do multiple activities at the same time)? If you do multi-task, what activities do you typically do at the same time?  | Other                         |
| How do you typically get around? (Check all that apply)  | Other                         |
| Do you commute to work or school? If yes, on average how much time (total) do you spend commuting each day?  | Other                         |
| How much are you able to relax and enjoy yourself?   | WHO                           |
| How often do you do leisure activities?  | WHO                           |
| What do you do in your leisure time? Think about all of the hobbies and leisure-time activities that you have done, including exercise and non-exercise activities (that is, any time when you are not working or studying).   | Terman                        |
| Thinking about the activities and hobbies that you do, what activities do you do most often  | Other                         |
| Thinking about the activities you do most often, how hard do you typically work?   | Other                         |
| <p>On a typical day (including both work and non-work time), how much time do you spend on each of the following activities?</p> <ul style="list-style-type: none"> <li>Sleeping</li> <li>Watching TV or videos</li> <li>Talking on the telephone</li> <li>Reading</li> <li>Using a computer</li> <li>Continuing education, increasing knowledge or skills</li> <li>Volunteer/community work</li> <li>Crafts or hobbies</li> <li>Sports or active recreation</li> <li>Competitive activities</li> <li>Physical self-improvement (diet, exercise)</li> <li>Going to concerts, plays, lectures, etc.</li> <li>Serious practice of the arts (e.g., singing, painting)</li> <li>Meetings of social groups or clubs</li> <li>Communicating with relatives, friends, &amp; neighbors</li> <li>Visiting with relatives, friends, &amp; neighbors</li> <li>Helping others (friends, relatives, neighbors, etc.)</li> </ul> | Combination<br>Terman/Hampson |
| List any clubs, organizations, or institutions to which you commit a substantial amount of time or interest.   | Terman                        |
| Outside of work, do you do any service activities (such as scout work, welfare or church work, community and civic affairs, etc.)? If so, please describe.   | Terman                        |
| <b>Part 4: Physical Activity</b>   |                               |
| During a usual week, how often do you do physical exercise for at least 20 minutes without stopping?   | Sallis                        |
| <p>Compared to others of your same age and sex,</p> <ul style="list-style-type: none"> <li>How active are you?</li> </ul>  | Sallis                        |

| Question   | Source                            |
|--|-----------------------------------|
| <ul style="list-style-type: none"> <li>• How fit are you?</li> <li>• How flexible are you?</li> <li>• How strong are you?</li> </ul>   |                                   |
| Do you have to limit your physical activity because of an illness, injury, or handicap? If yes, please specify why.  | Sallis                            |
| How does your current activity level compare to other periods of your life?  | Hampson                           |
| Have you had periods of your life when you engaged in no exercise and were physically quite inactive (like a “couch potato”)? Check all that apply.  | Hampson                           |
| Were you ever injured while exercising or playing a sport so that you had to limit your physical activity for a month or more?   | Sallis                            |
| When you were an adolescent (age 12-18), how active were you compared to others of your same age and sex?  | Sallis                            |
| What special activities or hobbies did you participate in during high school? Note any honors received (e.g., societies, athletic letters, etc.)   | Terman                            |
| What special activities or hobbies did you participate in during college? Note any honors received (e.g., societies, athletic letters, etc.)   | Terman                            |
| For each of the following periods of your life, to what extent did you enjoy physical education classes? (Elementary school, middle school, high school, college)  | Sallis                            |
| When you were growing up, how often were you forced to exercise or play sports? If so, who forced you?   | Sallis                            |
| Not counting yourself, are there any adults in your household who exercise at least 3 times a week for 20 minutes or more? If yes, who is that person (e.g., significant other, roommate)?   | Sallis                            |
| <p>Over the past 3 months, how often did your family or friends do the following?</p> <ul style="list-style-type: none"> <li>• Exercised with me</li> <li>• Offered to exercise with me</li> <li>• Encouraged me to exercise</li> <li>• Made fun of me or criticized me for exercising</li> <li>• Told me not to exercise</li> </ul>   | Sallis                            |
| How often do you see people walking, jogging, running, or biking in your neighborhood?   | Sallis                            |
| To what extent do you feel you live in a safe and secure environment?  | WHO                               |
| Are there any exercise programs or facilities where you work? If yes, do you use them?   | Sallis                            |
| <p>Think about how much you walk in a typical week. For each of the following, select how much time you spend walking and what your normal pace is (if applicable). If you walk – where do you usually walk?</p> <ul style="list-style-type: none"> <li>• Walking to &amp; from work/ school</li> <li>• Walking during breaks &amp; lunch</li> <li>• Walking to do errands for work</li> <li>• Walking to do errands for home or personal use</li> <li>• Walking with a pet</li> <li>• Walking for exercise</li> <li>• Walking with another person</li> <li>• Hiking</li> </ul>  | Sallis                            |
| Where do you usually exercise?   | Sallis                            |
| <p>When you think about participating in exercise or physical activity, to what extent do you believe the following will result from that activity?</p> <ul style="list-style-type: none"> <li>• I will feel less depressed or anxious</li> <li>• I will improve my self-esteem</li> <li>• I will meet new people</li> <li>• I will improve my relationships with others</li> <li>• I will lose weight</li> <li>• I will look better</li> <li>• I will build muscle strength</li> <li>• I will feel less tension and stress</li> <li>• I will improve my health</li> <li>• I will reduce my risk of illness</li> <li>• I will do better at my job</li> </ul> | Potential benefits scale - Sallis |

| Question   | Source            |
|--|-------------------|
| <ul style="list-style-type: none"> <li>• I will feel more attractive</li> <li>• I will improve my heart and lung fitness</li> </ul>  |                   |
| <p>How often do the following prevent you from exercising?</p> <ul style="list-style-type: none"> <li>• Feeling self-conscious about how I look</li> <li>• Lack of interest in exercise</li> <li>• Lack of self-discipline</li> <li>• Lack of time</li> <li>• Lack of energy</li> <li>• Lack of company</li> <li>• Lack of enjoyment from exercise</li> <li>• Feeling discouraged</li> <li>• Lack of equipment</li> <li>• Bad weather</li> <li>• Lack of skills</li> <li>• No facilities or space</li> <li>• Lack of child care</li> <li>• Lack of knowledge on how to exercise or use the equipment</li> <li>• Health problems</li> <li>• Fear of injury</li> <li>• Injury</li> </ul> | Barriers - Sallis |
| <b>Part 5: Other Health Behaviors</b>  |                   |
| How tall are you without shoes?  | Hampson           |
| About how much do you currently weigh (without shoes)?   | Hampson           |
| Are you currently on a diet to try to lose or gain weight? If yes, what plan are you following?  | Hampson           |
| How satisfied are you with the way your body looks?  | WHO               |
| Do you follow a special diet or have special dietary concerns?   | Other             |
| How many meals do you typically eat per day (not including snacks)?  | Other             |
| How many snacks do you typically eat per day?  | Other             |
| <p>To what extent do the following statements characterize your eating habits?</p> <ul style="list-style-type: none"> <li>• I eat whenever I feel hungry.</li> <li>• I try to follow a balanced diet.</li> <li>• I eat between meals.</li> </ul>   | Hampson & other   |
| <p>How often do you do the following?</p> <ul style="list-style-type: none"> <li>• Eat at a fast-food restaurant</li> <li>• Eat at a sit-down restaurant</li> <li>• Cook food at home or eat a home-cooked meal</li> <li>• Eat breakfast</li> </ul>  | Sallis & other    |
| Think about the foods that you have eaten on a typical day over the past month. How often do you generally eat or drink each of the following?   | Hampson & Sallis. |
| How many hours do you typically sleep at night?  | Other             |
| To what extent do you have difficulties with falling asleep, waking up during the night, or waking up too early?   | WHO               |
| In general, how would you rate the quality of your sleep?  | Hampson           |
| To what extent do you drink alcoholic beverages? (select) If you drink, what do you typically drink?   | Hampson           |
| <p>A drink is one can or bottle of beer, one glass of wine, one can or bottle of wine cooler, one cocktail, or one shot of liquor.</p> <ul style="list-style-type: none"> <li>• How many days in the past month did you drink an alcoholic beverage?</li> <li>• On the days you drank, about how many drinks did you consume?</li> <li>• How many times in the last 30 days did you have 5 or more drinks on a single occasion?</li> </ul>   | Hampson           |
| Have you smoked at least 100 cigarettes in your life (5 packs)? If yes, about how old were you when you first smoked?  | Hampson           |
| Have you ever been a regular smoker?   | Hampson           |
| <p>How many times in the past 30 days have you done the following?</p> <ul style="list-style-type: none"> <li>• Smoked cigarettes</li> </ul>   | Hampson           |

| Question   | Source                       |
|--|------------------------------|
| <ul style="list-style-type: none"> <li>• Smoked cigars</li> <li>• Used any smokeless tobacco products (such as chewing tobacco or snuff?)</li> </ul>   |                              |
| Are you currently trying to quit smoking?  | Hampson                      |
| <p>The following are different health behaviors that people often want to change to improve their health. For each one, select which statement best reflects your attitude on the behavior.</p> <ul style="list-style-type: none"> <li>• Eat less food each day (decrease the number of calories you eat)</li> <li>• Cut down on the stress in my life</li> <li>• Decrease how much alcohol I drink</li> <li>• Eat more fiber (cereals, whole grain breads)</li> <li>• Cut down (or quitting) smoking</li> <li>• Decrease the amount of sweets I eat (candy, desserts)</li> <li>• Eat less red meat</li> <li>• Eat fewer carbohydrates</li> <li>• Do more physical exercise</li> <li>• Decrease fat in my diet</li> <li>• Get more sleep</li> <li>• Eat more fruits and vegetables</li> <li>• Drink less caffeine</li> <li>• Cut down on salt</li> <li>• Gamble less</li> <li>• Watch less television</li> <li>• Spend more time with family</li> <li>• Spend more time with friends</li> <li>• Spend more time outside</li> </ul> | Stages of change<br>–Hampson |
| <b>Part 6: Social Relationships &amp; Support</b>  |                              |
| Not including yourself, how many people live in your household (including children)?   | Hampson                      |
| How many living siblings do you have?  | Terman                       |
| <p>Among your living siblings, with how many do you have each of the following relationships?</p> <ul style="list-style-type: none"> <li>• Intimate; we share most of our joys &amp; sorrows</li> <li>• Companionship; frequent interaction arising out of shared interests</li> <li>• Casual; we don't seek each other out</li> <li>• Indifferent/hostile; we actively avoid one another</li> </ul>   | Other                        |
| What is your current marital status?   | Terman                       |
| If you are married, how happy has your marriage been?  | Terman                       |
| If you live with a significant other, how happy has your relationship been?  | Other                        |
| Do you have any children? If so, please note how many. Of these, how many live at home?  | Terman                       |
| If you have children, how would you describe your relationships with them?   | Other                        |
| <p>Have you ever experienced any of the following?</p> <ul style="list-style-type: none"> <li>• Been legally married</li> <li>• Lived in a relationship as a domestic partner</li> <li>• Been widowed</li> <li>• Been divorced</li> <li>• Had biological children</li> <li>• Adopted children</li> </ul>   | Hampson                      |
| <p>Among the members of your immediate family &amp; close relatives (e.g., children, siblings, parents, grandparents, aunts, uncles, nieces, nephews, etc.), with about how many do you have each of the following relationships?</p> <ul style="list-style-type: none"> <li>• Intimate; we share most of our joys &amp; sorrows</li> <li>• Companionship; frequent interaction arising out of shared interests</li> <li>• Casual; we don't seek each other out</li> <li>• Indifferent/hostile; we actively avoid one another</li> </ul>   | Terman                       |
| How satisfied are you with your relationships with your family members?  | WHO, Terman                  |
| <p>Consider your 10 best friends (excluding family &amp; close relatives). How many of them would you place in each of the following categories?</p> <ul style="list-style-type: none"> <li>• Intimate; we share most of our joys &amp; sorrows</li> </ul>   | Terman                       |

| Question  | Source                            |
|---|-----------------------------------|
| <ul style="list-style-type: none"> <li>• Companionship; frequent interaction arising out of shared interests</li> <li>• Casual; we don't seek each other out</li> </ul>   |                                   |
| How satisfied are you with your relationships with your friends?  | WHO, Terman                       |
| To what extent can you count on your friends or family members to be there when you need them?  | WHO                               |
| To what extent do you feel alone in life?   | WHO                               |
| Do you provide care or assistance that some friend or relative needs? If yes, describe  | Terman                            |
| How satisfied are you with your ability to provide for or support others?   | WHO                               |
| <b>Part 7: Personality</b>  |                                   |
| <p>In each trait or characteristic below, compare yourself to others of the same age and gender. Read each of the options and mark the one that best describes you, as a person.</p> <ul style="list-style-type: none"> <li>• Healthy</li> <li>• High physical energy</li> <li>• Prudence &amp; forethought</li> <li>• Mechanical ingenuity</li> <li>• Will power &amp; perseverance</li> <li>• Desire to excel</li> <li>• Desire to know</li> <li>• Originality</li> <li>• Impulsiveness</li> <li>• Enjoyment of social contacts</li> <li>• Persistence in accomplishing your ends</li> <li>• Driven by a particular life purpose</li> </ul> | Terman                            |
| <p>Would you say the following describe you as a person or not?</p> <ul style="list-style-type: none"> <li>• You try to get your own way, even if you have to fight for it</li> <li>• You often in a state of excitement</li> <li>• Discipline make you discontented</li> <li>• You are the "stay-at-home" rather than the "out-and-about" type?</li> <li>• You enjoy planning your work in detail</li> <li>• You usually drive yourself steadily in your work</li> </ul>   | Terman                            |
| Please use the common human traits below to describe yourself. Describe yourself as you see yourself in the present, in relation to others you know of your age and sex (not how you'd like to be in the future).   | Hampson + a few added descriptors |
| <b>Part 8: Demographics</b>   |                                   |
| How did you hear about this study?  | Filter question                   |
| What is your sex?   | Hampson                           |
| What is your current age?   | filter question                   |
| Where were you born?  | Hampson                           |
| Where do you currently live?  | filter question                   |
| What is the highest grade or year of school you have completed?   | Hampson                           |
| Have you ever served in the armed services, or in the state or national guard?  | Hampson                           |
| What is your ethnicity?   | Hampson                           |

*Note:* Question sources refer to the following: Terman = Terman Life Cycle Study; Hampson = Hawaii Personality and Health Cohort Study; Sallis = San Diego Exercise and Health Study; WHO = World Health Organization Quality of Life Brief Scale; Other = a few questions from other miscellaneous surveys, to clarify the questions asked.

## Appendix 6

*PHAB study: 28 adjectives potentially relevant to activity*

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|                      |                  |
|----------------------|------------------|
| Achievement-oriented | Active           |
| Ambitious            | Apathetic        |
| Athletic             | Determined       |
| Diligent             | Driven           |
| Energetic            | Enterprising     |
| Goal-oriented        | Hardy            |
| Idle                 | Industrious      |
| Innovative           | Involved         |
| Lazy                 | Lethargic        |
| Persevering          | Persistent       |
| Productive           | Resilient        |
| Restless             | Self-disciplined |
| Strong-willed        | Stubborn         |
| Tireless             | Vigorous         |

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## Appendix 7

*PHAB study: Activities that participants usually engage in, with corresponding MET values*

| MET | Activity                           | MET | Activity                           |
|-----|------------------------------------|-----|------------------------------------|
| 1.0 | listening to music                 | 2.5 | piano                              |
| 1.0 | meditating                         | 2.5 | playing music                      |
| 1.0 | watching movies/tv                 | 2.5 | pool/ billiards                    |
| 1.1 | smoking                            | 2.5 | yoga                               |
| 1.3 | sex                                | 2.6 | teaching/tutoring                  |
| 1.5 | church, active participation       | 2.7 | volunteer work, hospital volunteer |
| 1.5 | collections                        | 2.0 | design                             |
| 1.5 | cross-word/ mind puzzles           | 2.8 | playing with dog                   |
| 1.5 | drinking                           | 3.0 | boating, sailing                   |
| 1.5 | eating                             | 3.0 | bowling                            |
| 1.5 | games                              | 3.0 | fishing                            |
| 1.5 | knitting, sewing                   | 3.0 | frisbee                            |
| 1.5 | reading                            | 3.0 | helping people                     |
| 1.6 | gambling, poker                    | 3.0 | surfing, body or board             |
| 1.8 | Attending concerts, movies         | 3.0 | walking dog                        |
| 1.8 | computer use, internet             | 3.1 | cleaning, housework                |
| 1.8 | drawing, painting                  | 3.2 | stagework/ tech                    |
| 1.8 | hang out w/ friends/ family        | 3.4 | family activity                    |
| 1.8 | research                           | 3.5 | archery                            |
| 1.8 | school/class                       |     | calisthenics - core work, home     |
| 1.8 | socializing                        | 3.5 | exercises                          |
| 1.8 | studying                           | 3.5 | Disneyland                         |
| 1.8 | talking on phone                   | 3.5 | walking (general)                  |
| 1.8 | talking/discussions                | 4.0 | acrobatics/tumbling                |
| 1.8 | txting                             | 4.0 | drums                              |
| 1.8 | work                               | 4.0 | gardening (general)                |
| 1.8 | writing                            | 4.0 | motorcross (ATV, quads), jeeping   |
| 1.9 | entertaining others                | 4.0 | ping pong                          |
| 1.9 | jigsaw puzzles                     | 4.0 | volleyball                         |
| 1.9 | partying                           | 4.0 | walking to/from class/work         |
| 1.9 | video/computer games               | 4.0 | weight-lifting (free, easy)        |
| 2.0 | crafts                             | 4.5 | dancing                            |
| 2.0 | driving                            | 4.5 | golf                               |
| 2.0 | grooming (doing nails, hair, etc.) | 4.5 | playing at park                    |
| 2.0 | music                              | 4.5 | playing with children              |
| 2.0 | photography                        | 4.8 | ballet                             |
| 2.0 | scrapbooking                       | 5.0 | baseball/softball                  |
| 2.0 | singing                            | 5.0 | kayaking                           |
| 2.0 | travel                             | 5.0 | skateboarding                      |
| 2.1 | visiting museums                   | 5.5 | gym/ working out (general)         |
| 2.2 | making videos                      | 5.5 | pilates                            |
| 2.3 | baking/cooking                     | 6.0 | basketball                         |
| 2.3 | going to the beach                 | 6.0 | fencing                            |
| 2.3 | shopping                           | 6.0 | hiking                             |
| 2.5 | camping                            | 6.0 | sports/ exercise (general)         |
| 2.5 | guitar                             | 6.0 | swimming (general)                 |
| 2.5 | motorcycle riding                  | 6.0 | water skiing/ wake boarding        |
|     |                                    | 6.0 | weight-lifting (heavy)             |

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| <b>MET</b> | <b>Activity</b>            |
|------------|----------------------------|
| 6.0        | workout (strenuous effort) |
| 6.5        | aerobics class             |
| 7.0        | backpacking                |
| 7.0        | cardio work (general)      |
| 7.0        | eliptical                  |
| 7.0        | ice skating                |
| 7.0        | jogging                    |
| 7.0        | kickball                   |
| 7.0        | paintball, airsoft         |

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|     |              |
|-----|--------------|
| 7.0 | racquetball  |
| 7.0 | scuba diving |

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| <b>MET</b> | <b>Activity</b> |
|------------|-----------------|
| 7.0        | snowboarding    |
| 7.0        | soccer          |
| 7.0        | tennis          |
| 8.0        | biking          |
| 8.0        | football        |
| 8.0        | hockey          |
| 8.0        | running         |
| 9.0        | rock climbing   |
| 9.0        | rugby           |
| 9.0        | water polo      |
| 10.0       | squash          |

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