HRS Documentation Report

Documentation of Physical Measures, Anthropometrics and Blood Pressure in the Health and Retirement Study

Report prepared by

Eileen Crimmins, University of Southern California
Heidi Guyer, University of Michigan
Kenneth Langa, University of Michigan
Mary Beth Ofstedal, University of Michigan
Robert Wallace, University of Iowa
David Weir, University of Michigan

Survey Research Center
University of Michigan
Ann Arbor, MI

February 2008

DR-011

Introduction

The assessment of physical performance is an important component of the evaluation of functioning of older persons. The HRS has employed a set of standardized assessments of lung function, grip strength, balance, and walking speed. In addition, HRS collected measures of blood pressure, height, weight, and waist circumference.

In 2006, HRS included the following measurements, administered in this order:

- Blood pressure
- Lung function
- Hand grip strength
- Balance tests
- Timed walk
- Height
- Weight
- Waist circumference

This report describes the following for each of the measures listed above:

- Rationale and key citations
- Sample description
- Measure description
- Equipment
- Protocol description
- Any special instructions

Information on saliva and blood spot collection will be provided in a separate report. The booklet that was used by the interviewers to administer the 2006 physical measures and biomarkers is available on the HRS website at:
http://hrsonline.isr.umich.edu/meta/2006/core/qnaire/online/44hr06BioMarker.pdf

Physical Measures in the 2004 Wave of HRS

In 2004, HRS administered a set of physical measures to a random subsample of about 3,300 respondents. In 2006, this effort was expanded in terms of both the size of the sample covered and the measurements that were conducted.

Information on the 2004 physical measures sample and content can be found in Section 8L in the 2004 Core Data Description on the HRS website:
http://hrsonline.isr.umich.edu/meta/2004/core/desc/h04dd.pdf

The booklet that was used to administer the 2004 physical measures is located at:
http://hrsonline.isr.umich.edu/meta/2004/core/qnaire/online/41hr04I.pdf

General Notes

Sample Selection for the Enhanced Face-to-Face Interview
A random one-half of the 2006 sample was pre-selected to complete an enhanced face-to-face interview, which included the eight measures listed above plus biomarker measurements (covered in a separate report) and the Psychosocial self-administered questionnaire. The sample was selected at the household-level to ensure that the same request was made to both members of a household. New spouses of respondents flagged to complete an enhanced face-to-face interview were also asked to do so.

The preload variable that identifies the enhanced face-to-face sample is KX090_R (located in the respondent preload file), for which a value of 3 indicates that the respondent was in the enhanced face-to-face sample. Approximately fifty percent of households with at least one living respondent were selected for the enhanced face-to-face interview across all primary sampling units (PSUs). Respondents who were selected for the enhanced face-to-face sample but were interviewed by proxy, residing in a nursing home or who declined a face-to-face interview, but agreed to be interviewed by telephone were not asked to complete the physical measures or biomarkers.

Consent Procedures
Prior to describing the individual measures, a consent form was administered by the interviewer. Respondents were asked to read and sign the form. Respondents who did not sign the consent form were not asked to complete the measures. After obtaining consent, the interviewer described the procedures to the respondent and demonstrated how each measure was conducted.

Administration Procedures
Before each measure, respondents were asked whether they understood the directions for the measurement and if they felt safe completing it. If the respondent answered no to either question, the measure was not administered. Likewise, interviewers were instructed not to administer a measure if they did not feel it was safe to complete it.

Respondents were instructed not to eat, drink, smoke, chew gum or brush their teeth during this component of the interview.

Additional eligibility criteria are listed below for each measure.

Blood Pressure and Pulse

Rationale

Blood pressure

Arterial blood pressure (BP) has been measured for well over a century, by various methods. Blood pressure varies from moment to moment and even in normal individuals is affected by many factors, such as time of day, diet, body mass index (BMI), exercise level, heart function, smoking and wide variety of environmental factors, such as noise and toxin exposure. There is

clearly a genetic component to elevated blood pressure (i.e., hypertension). Among older people, elevated BP levels are emerging as a risk factor for cognitive decline and dementia, at least in part due to clinical or subclinical stroke. Regardless of the causes of hypertension, it is related to a wide variety of clinical conditions such as coronary heart disease, stroke, kidney failure, retinal disease and many others. Clinical management of hypertension is associated with at least partial reduction of risk for many of these conditions.

In general, non-invasive measures of blood pressure, such as manual or automated sphygomanometry (inflated blood pressure cuffs) reflect true, directly measured intra-arterial blood pressure reasonably well, and these measures have been proven for both clinical and population applications. HRS uses an automated device that has been validated against manual measurement. It is important to note that in population studies, minimizing error in BP measurement is important, such as by repeated training of observers and assuring that the devices are in proper working order.

- Chobanian A. Clinical practice. Isolated systolic hypertension in the elderly. N Engl J Med. 2007 Aug 23;357(8):789-96.
- Ommen ES, et al. The role of ambulatory BP monitoring in clinical care. Geriatrics. 2007 Aug;62(8):11-4.
- Gyamlani G, et al. Secondary hypertension due to drugs and toxins. South Med J. 2007 Jul;100(7):692-9.
- McEniery CM, et al. Age, hypertension and arterial function. Clin Exp Pharmacol Physiol. 2007 Jul;34(7):665-71.
- Padwal RS, et al. The 2007 Canadian Hypertension Education Program recommendations for the management of hypertension: part 1- blood pressure measurement, diagnosis and assessment of risk. Can J Cardiol. 2007 May 15;23(7):529-38.
- Tzourio C. Hypertension, cognitive decline, and dementia: an epidemiological perspective. Dialogues Clin Neurosci. 2007;9(1):61-70.

Pulse

A resting pulse indicates the heart rate or the number of heart beats per minute (bpm). The pulse is lower when one is at rest and elevated when one exercises, which requires more oxygen-rich blood. While a pulse is often described by rate (bpm), the strength and rhythm of the heartbeat may also be used as indicators of some medical conditions. In some participants, there is likely to be some modest variation and error in assessing the radial artery pulse at the wrist. Also, in persons with heart rhythm disturbances or obstruction in the radial artery, not all heart beats may be detected.

Pulse rate has a long history of being used as a risk factor to predict cardiovascular disease (CVD) occurrence and to predict death and other clinical outcomes when CVD is in place. Interpreting pulse rate can be difficult, however, because there are so many factors that lead to the heart rate, including habitual physical activities, smoking habits, intrinsic aging of the heart's conducting system (which mediates the heart rhythm), various kinds of CVD and many other illnesses that have an effect on the vascular system, many types of medications (cardiac and others), and external environmental stresses. Women have been shown to have higher resting

pulse rate than men and white women have higher pulse rates than black women. Blood pressure and body temperature have been related to higher pulse rates independent of multiple other causes. Interventions such as education and programs of physical activity have been shown to reduce resting pulse rate, and various medications have been used to reduce elevated heart rates in persons with CVD, in the hope of reducing the increased mortality risk.

- Fox K, et al. Resting heart rate in cardiovascular disease. J Am Coll Cardiol. 2007;50:823-830.
- Lanza GA, et al. Heart rate: a risk factor for cardiac disease and outcomes? Pathophysiology of cardiac diseases and the potential role of heart rate slowing. Adv Cardiol 2006;43:1-16.
- Gillum RF. Epidemiology of resting pulse rate of persons ages 25-74--data from NHANES 1971-74. Public Health Rep. 1992 Mar–Apr; 107(2): 193–201.
- Gillum RF, Makuc DM, Feldman JJ. Pulse rate, coronary heart disease, and death: the NHANES I Epidemiologic Follow-up Study. Am Heart J. 1991 Jan;121(1 Pt 1):172-7.
- Farquhar JW, Fortmann SP, Flora JA, Taylor CB, Haskell WL, Williams PT, Maccoby N, Wood PD. Effects of communitywide education on cardiovascular disease risk factors. The Stanford Five-City Project. JAMA, Vol. 264 No. 3, July 18, 1990
- Young DR, Haskell WL, Jatulis DE, Fortmann SP. Associations between Changes in Physical Activity and Risk Factors for Coronary Heart Disease in a Community-based Sample of Men and Women: The Stanford Five-City Project. American Journal of Epidemiology Vol. 138, No. 4: 205-216.
- Sanchez-Delgado E, Liechti H. Lifetime risk of developing coronary heart disease.[comment]. Comment on: Lancet. 1999 Jan 9;353(9147):89-92.

Sample

All those meeting criteria described above were included unless the respondent reported having a rash, a cast, edema or swelling in the arm, open sores or wounds or a significant bruise where the blood pressure cuff will be in contact.

Measurement

Three measurements, 45 seconds apart, were taken on the respondent's left arm. Data recorded for each measurement include systolic and diastolic blood pressure, pulse, and the time of day the reading was taken.

Equipment

Omron HEM-780 Intellisense Automated blood pressure monitor with ComFit cuff.

Protocol

- Respondents were instructed to sit down with both feet on the floor and their left arm comfortably supported (on a table for example) with the palm facing up. Respondents were asked to roll their sleeve up unless they had on a short sleeve shirt or a thin shirt.
- The cuff was adjusted to the respondent's arm ensuring that it made direct contact with the skin, the bottom of the cuff was approximately half an inch above the elbow and the air tube ran down the middle of the respondent's arm.
- The interviewer pressed the start button.
- The cuff inflated automatically and then deflated while displaying the systolic and

diastolic blood pressure and pulse.

- The interviewer recorded the systolic and diastolic blood pressure and pulse, as well as the time of the reading.
- The interviewer used a stop watch and waited 45-60 seconds before beginning the next measurement.
- Three readings were taken.

Special instructions

Interviewers were instructed to turn the monitor away from the respondent so that the respondent would not see the readings during the measurements, as viewing the reading could affect subsequent blood pressure and pulse measurements.

Interviewers were instructed to remain quiet and not to respond to a respondent's inquiry regarding the reading while the three measurements were being taken.

If the lowest blood pressure reading obtained was higher than 160 systolic or higher than 110 diastolic (160/110), interviewers were instructed to record the measurements on a pre-designed card instructing the respondent to consult their physician as soon as possible.

Lung Function

Peak expiratory flow is one of several common and clinically applied physiological measures of lung function. It is not the most fundamental, and overall can't replace FEV1 (the proportion of the total amount of air exhaled in the first second of a single breath) or minute volume (the total amount of air that can be breathed in one minute). Peak expiratory flow is of value because it is a measure of obstructive lung disease, such as in asthma or chronic obstructive lung disease (emphysema). It is used in population studies because it is a reliable, inexpensive measure that can be performed with a portable device. However, as in most measures of lung function, its validity depends on the participants willingness to give a maximum respiratory effort. Clinically, it is often used to monitor therapeutic progress in patients with airway obstruction. Past research has shown peak expiratory flow to be related to mortality (Cook et al., 1999), cognitive decline (Albert et al., 1995) and physical decline (Seeman et al., 1994).

- Albert MS, Jones K, Savage CR, Berkman L, Seeman T, Blazer D, Rowe JW. Predictors of cognitive change in older persons: MacArthur studies of successful aging. Psychol Aging. 1995 Dec;10(4):578-89.
- Seeman TE, Charpentier PA, Berkman LF, Tinetti ME, Guralnik JM, Albert M, Blazer D, Rowe JW. Predicting changes in physical performance in a high-functioning elderly cohort: MacArthur studies of successful aging. J Gerontol. 1994 May;49(3):M97-108.
- Nancy R. Cook, Denis A. Evans, Paul A. Scherr, Frank E. Speizer, James O. Taylor and Charles H. Hennekens. (1991). Peak Expiratory Flow Rate and 5-Year Mortality in an Elderly Population. American Journal of Epidemiology Vol. 133, No. 8: 784-794

Sample

All those meeting criteria described above were included unless the respondent reported having the flu or other contagious illness.

Measure
Three measurements, 30 seconds apart, were conducted.

Equipment
Mini-Wright Peak Flow Meter with a disposable mouthpiece.

Protocol

- The interviewer handed the peak flow meter and a disposable mouthpiece to the Respondent and asked that they place the mouthpiece firmly on the meter.
- Respondents were instructed to stand up, take a deep breath, place their lips around the mouthpiece and blow as hard and as fast as possible.
- The interviewer recorded the value indicated by the pointer and reset the meter.
- The interviewer used a stop watch and waited 30 seconds before beginning the next measure.
- Up to three readings were obtained.

Special instructions
Interviewers were instructed to stop the measurement if the respondent became dizzy, wheezy or had a coughing attack.

If the respondent coughed or laughed during a measurement, the measurement was repeated.

Hand Grip Strength

Handgrip, usually using a pistol grip device (see below) is a measure of two general conditions: a) the state of general muscle strength, and it depends on muscle development, exercise and general medical and metabolic status of the participant; and b) the presence of arthritis and other conditions in the hand, and thus hand grip is used to monitor progress in the management of joint conditions that affect the hand, such as degenerative (osteo-) arthritis or rheumatoid arthritis. A participant might have difficulty with the test if he/she has a skin condition that affects the ability to hold the instrument. Willingness and ability to provide a maximal effort is also important here.

Hand grip strength has been found to be related to important health outcomes and indicators. Hand grip strength in midlife is shown to be highly predictive of functional limitations and disability in older ages (Giampaou et al., 1999; Rantanen et al., 1999), mortality (Snih et al., 2002) and health-related quality of life (Sayer et al., 2006). Studies have also shown the association of low grip strength with high levels inflammatory markers such as CRP and IL-6 (Cesari et al., 2004).

- Snih, S., Markides, K., Ray, L, Ostir, G., & Goodwin, J. (2002). Handgrip Strength and Mortality in Older Mexican Americans. Journal of the American Geriatrics Society, 50(7), 1250-1256.
- Cesari M., Penninx B., Pahor M., Lauretani F., Corsi A., Williams GR, Guralnik JM, Ferrucci L. (2004). Inflammatory Markers and Physical Performance in Older Persons: The

InCHIANTI Study. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 59:M242-M248.
- Rantanen T, Guralnik J, Foley D, Masaki K, Leveille S, Curb D, White L. Midlife Hand Grip Strength as a Predictor of Old Age Disability. *JAMA.* 1999;281:558-560.
- Giampaou S, Ferrucci L, Cecchi F, Noce C, Poce A, Dima F, Santaquilani A, Vescio M, Menotti A. (1999). Hand-grip strength predicts incident disability in non-disabled older men. Age and Ageing, 28, 283-288.
- Avan Aihie Sayer, Holly E. Syddall, Helen J. Martin, Elaine M. Dennison, Helen C. Roberts, Cyrus Cooper (2006). Is grip strength associated with health-related quality of life? Findings from the Hertfordshire Cohort Study. *Age and Ageing* 2006; 35: 409–415.

Sample
All those meeting criteria described above were included unless the respondent reported having had surgery, swelling, inflammation, severe pain or injury in both hands in the past six months. If any of these symptoms were present in only one hand, the measurement was conducted with the other hand.

Measure
Two measurements were taken for each hand, alternating hands.

Equipment
Smedley spring-type hand dynamometer.

Protocol
- The dynamometer was fit to the respondent's hand and the respondent practiced once with their dominant hand in a standing position with their arm at their side at a 90 degree angle.
- The respondent was instructed to squeeze the meter as hard as they were able for a couple of seconds and to then let go.
- After the practice measurement, the respondent was instructed to switch to their non-dominant hand.
- Two measurements were taken with each hand, alternating hands.
- After each measurement, the interviewer recorded the result and handed the dynamometer back to the respondent.

Special instructions
If the respondent was unable to stand, the measurement was completed with the respondent seated.

If the respondent had difficulty holding the dynamometer, the respondent was allowed to perform the measurement was conducted with their upper arm resting on a table or other object for support.

If the measurement was only performed with one hand, the interviewer instructed the respondent to wait 30 seconds between each measurement.

Balance Tests (Tandem, Semi Tandem, Side-by-Side)

Static balance was evaluated in HRS 2006 with three separate, progressively more difficult stances: side-by-side, semi-tandem, and tandem. In HRS, the mid-level balance test (semi-tandem) is conducted first, progressively testing either the full tandem or the side by side stance depending on the performance on the semi-tandem test.

Balance tests have been found to be useful predictors of health outcomes such as mortality (Guralnik et al., 1994; Laukkanen et al., 1995), disability (Guralnik et al., 1994, 1995), institutionalization (Guralnik et al., 1994), inflammation (Cesari et al., 2004), and the risk of falls. Poorer balance test is also found to be related to high level of inflammatory markers such as IL-6, CRP, and IL-1RA (Cesari et al., 2004).

- Cesari M., Penninx B., Pahor M., Lauretani F., Corsi A., Williams GR, Guralnik JM, Ferrucci L. (2004). Inflammatory Markers and Physical Performance in Older Persons: The InCHIANTI Study. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 59:M242-M248.
- Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994 Mar;49(2):M85-94.
- Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *N Engl J Med.* 1995;332:556–561.
- Laukkanen P, Heikkinen E, Kauppinen M. Muscle strength and mobility as predictors of survival in 75–84-year-old people. Age Aging 1995;24:468–73.

Sample

All those meeting criteria described above were included unless the respondent was unable to stand unassisted for at least one minute. All respondents attempted the Semi-Tandem stand. If they were able to hold this stand for 10 seconds, they were then asked to do the Full Tandem stand. Respondents aged 65 or older were asked to complete a 30 second balance test while those younger than 65 were asked to complete a 60 second balance test. If they were unable to hold the Semi-Tandem for 10 seconds, they were asked to perform the Side-by-Side Tandem stand.

Interviewers were instructed to discuss the respondent's ability to conduct each individual test of balance if the respondent reported problems from recent surgery, injury or other conditions that might prevent them from standing up from a chair and balancing.

Measure

Up to two of the following measures of balance were conducted: Full Tandem, Semi-Tandem, Side-by-Side.

Equipment

A diagram showing the foot positions for the different balance stands and a stop watch.

Protocol

Semi-Tandem

- The respondent was asked to stand up with the side of the heel of one foot touching the big toe of the other foot for about 10 seconds.
- The respondent could put either foot in front and use their arms, bend their knees or move their body to maintain balance, but was instructed to try not to move their feet.
- If necessary, the interviewer was instructed to gently support the respondent's arm to help them get into the semi-tandem position. The interviewer stood to the side of the respondent to be in position to assist if a respondent lost his/her balance.
- The respondent was instructed to try to hold this position until told to stop.
- The interviewer stopped the stopwatch after 10 seconds or when the respondent stepped out of position or grabbed the interviewer's arm.

Tandem

- Same protocol as for semi-tandem, except that the respondent was asked to stand to stand with the heel of one foot in front of and touching the toes of the other foot for about [30/60] seconds.
- The interviewer stopped the stopwatch after [30/60] seconds or when the respondent stepped out of position or grabbed the interviewer's arm.

Side-by-Side

- Same protocol as for semi-tandem, except that the respondent was asked to stand to stand with both feet together, side-by-side, for about 10 seconds.
- The interviewer stopped the stopwatch after 10 seconds or when the respondent stepped out of position or grabbed the interviewer's arm.

Special instructions

Interviewers assessed the appropriateness of the respondent's footwear before conducting the test. If necessary, respondents were asked to remove their shoes or to wear low or no heeled shoes.

The interviewer was instructed conduct the test in an area where the floor was level, preferably with no or low-pile carpet.

If a respondent was not able to perform the test for the full amount of time, the interviewer recorded the amount of time the position was held.

Timed Walk

The timed walk test is a quick, inexpensive, and highly reliable measure of functional capacity that can be easily done in the home interview.

It has been shown that gait speed predicts major health outcomes for older people such as self-reported health (Jylhä et al., 2001), mortality (Corti et al., 1994; Guralnik et al., 1994; Melzer et al., 2003), disability (Guralnik et al., 1994, 1995; Ostir et al., 1998), recurrent falls (Bath and Morgan, 1999), hip fracture (Dargent-Molina et al., 1996) and nursing home admission (Guralnik et al., 1994). It has also been related to inflammation (Cesari et al., 2004).

- Bath PA, Morgan K. Differential risk factor profiles for indoor and outdoor falls in older people living at home in Nottingham, UK. Eur J Epidemiol 1999;15:65–73.
- Dargent-Molina P, Favier F, Grandjean H et al. Fall-related factors and risk of hip fracture: The EPIDOS prospective study. Lancet 1996;348: 145–149.
- Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994 Mar;49(2):M85-94.
- Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. *N Engl J Med.* 1995;332:556–561.
- Marja Jylhä, Jack M. Guralnik, Jennifer Balfour, Linda P. Fried. (2001). Walking difficulty, walking speed, and age as predictors of self-rated health: the Women's Health and Aging Study. *Journal of Gerontology MEDICAL SCIENCES* 2001, Vol. 56A, No. 10, M609–M617
- Melzer D, Lan TY, Guralnik JM. The predictive validity for mortality of the index of mobility-related limitation. Results from the EPESE study. Age Ageing 2003;32:619–625.
- Ostir GV,Markides KS, Black SA et al. Lower body functioning as a predictor of subsequent disability among older Mexican Americans. J Gerontol A Biol Sci Med Sci 1998;53:M491–M495.
- Corti MC, Guralnik JM, Salive ME et al. Serum albumin level and physical disability as predictors of mortality in older persons. JAMA 1994;272:1036–1042.
- Cesari M., Penninx B., Pahor M., Lauretani F., Corsi A., Williams GR, Guralnik JM, Ferrucci L. (2004). Inflammatory Markers and Physical Performance in Older Persons: The InCHIANTI Study. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* 59:M242-M248.

Sample

All respondents aged 65 years or older meeting the criteria described above and who do not have any problems from recent surgery, injury, or other health conditions that might prevent them from walking were eligible for the timed walk test. Additionally, sufficient space was necessary to conduct the test. A clear, preferably non-carpeted area, approximately 12 feet in length was needed to set up the walking course.

Measure

Respondents were timed as they walked the 98.5 inch course two times (there and back).

Equipment
Stop Watch
Tape Measure (pre-marked at 98.5 inches)
Masking Tape (to mark the course)

Protocol

- The interviewer set up a walking course by placing the tape measure on the floor to measure the full distance.

- The interviewer placed a strip of masking tape, approximately 8 inches long, on the floor to mark the starting and ending points of the course.

- The interviewer retrieved the tape measure from the floor and instructed the respondent to place their toes at the start of the course.

- The interviewer said, "Ready, begin" to signal to the respondent to begin walking.

- The interviewer started the stop watch once the respondent's foot was across the starting line and fully touching the floor.

- The respondent was instructed to walk at their normal pace just past the end of the course.

- The interviewer stopped the stop watch as soon as the respondent's foot was completely past the masking tape marking the finish line and fully touched the floor.

- The interviewer reset the stop watch and instructed the respondent to walk back to the other side.

- The interviewer timed the second walk as well and recorded the information in the booklet.

Special instructions
Respondents were instructed to wear appropriate footwear (low or no heel). The interviewer walked just to the side and slightly behind the respondent so as to clearly see the respondent's feet as they crossed the line, but also to gently support the respondent if they lost their balance or started to fall. This measure could be completed with a walking aid, such as a cane or a walker, if a respondent normally used an aid to walk.

Height

In the HRS, height was measured by having the respondent stand against a wall, without shoes. A mark was made on a post-it on the wall by the interviewer, who then measured the distance from the floor to the mark.

Adult height is determined not only by genetic endowment but also by health, nutrition/diet and psychological stress through the developmental years. In the later years, shrinkage in height is common, and is partly due to progressive osteoporosis, more frequent in women. Social and developmental factors related to adult height include parental height, birth weight, childhood social class, birth order, number of younger siblings, year of birth, parental education, household crowding, childhood diet, and serious illness in childhood.

Maximum attained height and change in height have been shown to be related to the risk of chronic conditions, diseases and death among older persons. There is an inverse association between height and overall mortality (Davey Smith et al., 2000; Song et al., 2003), with stroke (McCarron et al., 2001; Song et al., 2003), and with cardiovascular disease (Davey Smith et al., 2000; Gunnell et al., 2003). On the other hand the association between height and cancer is positive (Davey Smith et al., 2000; Gunnell et al., 2001). Because height is determined relatively early in life, the association of greater stature with an increased risk of cancer and a decreased risk of cardiovascular disease appears to reflect the long-term consequences of pre-adult conditions.

- Davey Smith, G., Hart, C., Upton, M., Hole, D., Gillis, C., Watt, G., et al (2000). Height and risk of death among men and women: Aetiological implications of associations with cardiorespiratory disease and cancer mortality. *Journal of Epidemiology and Community Health, 54*, 97-103.
- Gunnell, D., Okasha, M., Davey Smith, G., Oliver, S., Sandhu, J., & Holly, J. (2001). Height, leg length and cancer risk: A systematic review. *Epidemiological Review, 23*, 313-342.
- Gunnell, D., Whitley, E., Upton, M.N., McConnachie, A., Davey Smith, G., & Watt, G.C.M. (2003). Associations of height, leg length and lung function with cardiovascular risk factors in the Midspan Family Study. *Journal of Epidemiology and Community Health, 57*, 141-146.
- McCarron, P., Hart, C.L., Hole, D., & Davey Smith, G. (2001). The relation between adult height and haemorrhagic and ischaemic stroke in the Renfrew/Paisley study. *Journal of Epidemiology and Community Health, 55*, 404-405.
- Song, Y.M., Davey Smith, G., & Sung, J. (2003). Adult height and cause-specific mortality: A large prospective study of Korean men. *American Journal of Epidemiology, 158*, 479-485.

Sample

All respondents who met the criteria described above and were able to stand were eligible for this measure.

Measure

The respondent's height was measured as they stood against a wall.

Equipment
A tape measure, rafter's square, an adhesive note and pen were used for this measure.

Protocol
- The respondent was instructed to remove their shoes and stand against a wall with their heels and shoulders against the wall.
- An adhesive note was placed on the wall just behind the top of the respondent's head.
- The interviewer placed the rafter's square on the respondent's head and parallel against the wall.
- The respondent marked the adhesive note at the bottom of the rafter's square marking the respondent's height.
- The interviewer asked the respondent to move away from the wall.
- The interviewer used the tape measure to determine the respondent's height by measuring from the floor up the mark on the adhesive note.
- The respondent's height was recorded in inches to the nearest quarter inch.
- The adhesive note was removed from the wall.

Special instructions
This measure was not conducted if there was not sufficient space available. Interviewers could request something to stand on if they were unable to conduct the measure due to a difference in height (if the interviewer was much shorter than the respondent).

Weight

Those with higher values of BMI tend to be at higher risk for hypertension, adult-onset diabetes mellitus, heart disease, stroke, various forms of cancer, atherosclerosis (Folsom et al., 1994; Lapidus et al., 1984; Larsson et al., 1984; McKeigue et al., 1991), osteoarthritis (Felson et al., 1992), the onset of functional impairment, (Jenkins, 2004), increased inactivity, resulting in lower aerobic capacity and less muscle strength (Andersen et al., 2001), and disability (Blaum et al., 2003; Davison et al., 2002; Dey et al., 2002; Himes, 2000; Must et al., 1999). Weight change, commonly defined as a change in BMI, is an important predictor of various health outcomes such as functional impairment and disability (Ferraro, Su, Gretebeck, Black, & Badylak, 2002; Jenkins, 2004; Launer, Harris, Rumpel, & Madans, 1994)

- Andersen, R.E., Franckowiak, S., Christmas, C., Walston, J. & Crespo, C. (2001). Obesity and reports of no leisure time activity among old Americans: Results from the third national health and nutrition examination survey. *Educational Gerontology, 27*, 297-306.
- Blaum, C.S., Ofstedal, M.B., Langa, K.M., & Wray, L.A. (2003). Functional status and health outcomes in older Americans with diabetes mellitus. *Journal of the American Geriatrics Society, 51*, 745-753.
- Davison, K.K., Ford, E.S., Cogswell, M.E., & Dietz, W.H. (2002). Percentage of body fat and body mass index are associated with mobility limitations in people aged 70 and older from NHANES III. *Journal of the American Geriatrics Society, 50*, 1802-1809.
- Dey, D.K., Rothenberg, E., Sundh, V., Bosaeus, I., & Steen, B. (2002). Waist circumference, body mass index, and risk for stroke in older people: A 15-year old longitudinal population study of 70-year olds. *Journal of the American Geriatrics Society, 50*, 1510-1518.

- Felson, D.T., Zhang, Y., Anthony, J.M., Naimark, A. & Anderson, J.J. (1992). Weight loss reduces the risk for symptomatic knee osteoarthritis in women. *Annals of Internal Medicine, 116*, 535-539.
- Ferraro, K.F., Su, Y., Gretebeck, R.J., Black, D.R., & Badylak, S. (2002). Body Mass Index and disability in adulthood: A 20-year panel study. *American Journal of Public Health*, 92(5), 834-840.
- Folsom, A.R., Kaye, S.A., Sellers, T.A., Hong, C., Cerhan, J.R., Potter, J.D., et al (1993). Body fat distribution and 5-year risk of death in older women. *Journal of the American Medical Association, 269*, 483-487.
- Himes, C.L. (2000). Obesity, disease, and functional limitation in later life. *Demography, 37(1)*, 73-82.
- Jenkins, K.R. (2004). Body Weight Change and Physical Functioning Among Young Old Adults. Journal of Aging and Health, 16(2), 248-266.
- Jenkins, K.R. (2004). Obesity's Effects on the Onset of Functional Impairment Among Older Adults. *The Gerontologist*, 44(2), 206-216.
- Lapidus, L., Bengtsson, C., Larsson, B., Pennert, K., Rybo, E., & Sjostrom, L. (1984). Distribution of adipose tissue and risk of cardiovascular disease and death: A 12 year follow up of participants in the population study of women in Gothenburg, Sweden. *British Medical Journal, 289*, 1257-1261.
- Larsson, B., Svardsudd, K., Welin, L., Wilhelmsen, L., Bjorntorp, P., & Tibblin, G. (1984). Abdominal adipose tissue distribution, obesity, and risk of cardiovascular disease and death: 13 year follow up of participants in the study of men born in 1913. *British Medical Journal, 288*, 1401-1404.
- Launer, L.J., Harris, T., Rumpel, C., & Madans, J. (1994). Body mass index, weight change, and risk of mobility disability in middle-aged and older women. *Journal of American Medical Association*, 271(14), 1093-1098.
  McKeigue, P.M., Shah, B., & Marmot, M.G. (1991). Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular in South Asians. *Lancet, 337*, 382-386.
- Must, A., Spadano, J., Coakley, E.H., Field, A.E., Colditz, G., & Dietz, W.H. (1999). The disease burden associated with overweight and obesity. *Journal of the American Medical Association, 28*2, 1523-1529.

Sample

All respondents who met the criteria described above were eligible for this measure unless their self-reported current weight (collected earlier in the interview) was 300 pounds or greater, or they were unable to stand.

Measure

Respondents were asked to step on a scale to measure their weight.

Equipment

All interviewers were equipped with a Healthometer 830KL scale.

Protocol

- An appropriate spot to place the scale, preferably a non-carpeted area, was identified.
- Respondents were instructed to remove their shoes, any bulky clothing and heavy objects

from them pockets.

- The interviewer tapped the scale and waited until a "0" appeared in the display.
- The respondent stepped up on the scale and stood on it until the weight was displayed.
- The interviewer recorded the respondent's weight to the nearest half pound.

Special instructions

Weight was measured using the scale provided to the interviewer. The maximum weight measured using this scale is 330 pounds. If the respondent's weight was greater than 330, an E for error was displayed. In this situation, the interviewer recorded that the measure was not conducted.

Waist circumference

Sometimes, waist circumference (WC) is preferred to BMI as a predictor for cardiovascular risk (Dagenais et al., 2005) and other adiposity-related conditions. While BMI provides an index of obesity, waist circumference may be more useful as an index of more chronic levels of metabolism and adipose tissue deposition (Seeman et al., 1997). Researchers have argued that it is not obesity per se but the distribution of the adipose tissue that is related to increased risk (Ducimetiere, Richard, Cambien, Avous, & Jacqueson ; National Heart, Lung, and Blood Institute, 1998). Those with an apple body shape or a central distribution of fat tend to experience higher rates of atherosclerotic heart disease, stroke, hypertension, hyperlipidemia and diabetes than those with a pear body shape. According to the guidelines for defining metabolic syndrome (Butler, Sprott, Warner, et al., 2004), the use of a simple measure of waist circumference instead of BMI is recommended to identify the body weight component of metabolic syndrome (men>40 inches; women>35 inches).

- Butler R.N., Sprott R., Warner H., et al. (2004). Biomarkers of aging: from primitive organisms to humans. *Journals of Gerontology: Biological Sciences and Medical Sciences*, 59, 560-567.
- Dagenais, G.R., Yi, Q., Mann, J.F.E., Bosch, J., Pogue, J., & Yusuf, S. (2005). Prognostic impact of body weight and abdominal obesity in women and men with cardiovascular disease. *American Heart Journal,* 14*9,* 54-60.
- Ducimetiere, P., Richard, J., Cambien, F., Avous, P, Jacqueson, A. (1985). Relationship between adiposity measurements and the incidence of coronary heart disease in a middle-aged male population: The Paris Prospective Study I. *American Journal of Nutrition*, 4, 31-38.
- National Heart, Lung, and Blood Institute. (1998). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. Washington, D.C.: U.S. Public Health Service.
- Seeman, T.E., Singer, B.H., Rowe, J.W., Horwitz, R.I., & McEwen, B.S. (1997). Price of adaptation--allostatic load and its health consequences. MacArthur studies of successful aging [published erratum appears in (1999), *Archives of Internal Medicine, 159(11)*, 1176]. *Archives of Internal Medicine, 157(19)*, 2259-2268.

Sample
All respondent's who met the criteria described above and were able to stand and raise their arms to place the tape measure around their waist were eligible for this measure.

Measure
The respondent's waist circumference was measured at the level of their navel.

Equipment
Tape measure

Protocol
- Respondents were asked to stand up and remove any bulky clothing.
- The respondent was asked to point to their navel and to place the tape measure around their waist at the level of their navel.
- The interviewer checked to be sure that the tape measure was horizontal around the waist and snug but not tight.
- The respondent was instructed to inhale and slowly exhale, holding their breath at the end of the exhale.
- The tape measure was adjusted if necessary and the waist circumference measured while holding the exhale.

Special instructions
Waist circumference was measured at the height of the navel regardless of whether this was the smallest point or the natural waist. If the respondent was unable to place the measure around their waist, the interviewer could help them to do so. The measure was conducted over a thin layer of clothing.