Adherence to the 2008 Physical Activity Guidelines and Mortality: Findings from Linked NHIS (1997-2004) and NDI (1997-2006) Data

Manfred Stommel, PhD,
Michigan State University &
2008-2009 Academy Health Senior Service Fellow

Charlotte A. Schoenborn, MPH,
National Center for Health Statistics, DHIS

Context:

In the fall of 2008, the U.S. Department of Health and Human Services issued the *2008 Physical Activity Guidelines for Americans*.

These Guidelines represented a shift away from specific frequencies and durations of vigorous and moderate activities. Instead, the *2008 Guidelines* established targets for total amounts of physical activity, which could be achieved in multiple/flexible ways, with 1 minute of vigorous physical activity equating to 2 minutes of moderate activity .

Objectives:

1. The primary objective in this presentation is to assess the all-cause mortality risks associated specifically with the levels of aerobic and muscle strengthening activities recommended in the *2008 Physical Activity Guidelines for Americans* for adults, using leisure-time physical activities as the measures of these activities.

2. A secondary objective is to examine how the presence or absence of chronic conditions modifies the association between meeting *2008 Guidelines* recommendation and all-cause mortality.

Recommendations for Physical Activity of Adults (2008 Guidelines):

Aerobic Activity:

1. "Sufficiently active": ≥ 150 minutes of moderate aerobic activity per week or ≥ 75 minutes of vigorous activity

2. "Highly active": >300 minutes of moderate aerobic activity per week or >150 minutes of vigorous activity

Muscle Strengthening (in addition to Aerobics):

3. At least 2 days of Muscle Strengthening Exercises per week involving all major muscle groups

Data

1. The Analytic File combines 8 years (1997-2004) of data from the National Health Interview Survey (NHIS) and the linked mortality files of the National Death Index (NDI) containing follow-up information through 12/31/2006.

2. Information on height and weight as well as leisure-time physical activity was obtained from the NHIS "Sample Adult", a sample of adult (18+) interview respondents, each of whom is randomly chosen from the adult members of a household (if more than one adult is present).

Procedures for NHIS-NDI Linkage and Subsequent Analysis:

1. To be eligible for linkage between the NHIS and NDI data, a case/record had to contain one of the following combinations of identifying information:

   ❖ Social Security #, sex, full date of birth
   ❖ Last name, first initial, month of birth, year of birth
   ❖ Last name, first initial, Social Security #

2. Estimates for all analyses were weighted using post-stratification to adjust for missing cases due to eligibility status.

Number of Cases in Data Files Linking 1997-2004 NHIS to 1997-2006 NDI Data

Year of NHIS Data Collection	NHIS Sample Adult Respondents (Aged 18+)	NHIS Respondents meeting eligibility criteria for linkage to NDI	Linked NHIS Respondents who died at or before 12/31/2006
1997	36,116	34,393	3,956
1998	32,440	30,577	3,226
1999	30,801	29,076	2,542
2000	32,374	30,595	2,231
2001	33,326	31,358	1,937
2002	31,044	28,995	1,413
2003	30,852	28,210	1,095
2004	31,326	29,193	739
Totals:	258,279	242,397	17,139

KEY VARIABLES 1:

1. Mortality Status

   (Outcome coded 1=deceased, 0=assumed alive) is based on three sources:

   1. NDI Match,

   2. Social Security Administration,

   3. Centers for Medicare and Medicaid Services

   Maximum follow-up until censoring is 3639 days (≈10 years) from the NHIS interview; minimum follow-up until censoring is at least 731 days (= 2 years).

KEY VARIABLES 2:

2. Following the DHHS 2008 Physical Activity Guidelines for Americans, respondents were classified into four major groups:

(1) Met neither muscle strengthening nor aerobic activity recommendation

(2) Met muscle strengthening recommendations only (≥ 2 days per week of muscle strengthening exercise)

(3) Met aerobic exercise recommendations only (leisure-time aerobic activity ≥ 150 min.)

(4) Met both aerobic and muscle strengthening recommendations

KEY VARIABLES 3:

3. Alternatively, using the DHHS 2008 Physical Activity Guidelines for Americans, respondents were classified into four major aerobic exercise groups:

    (1) "Inactive" (no leisure time physical activity)

    (2) "Somewhat active" (leisure-time aerobic activity < 150 min. per week).

    (3) "Active" (leisure-time aerobic activity ≥ 150 min. per week but ≤300).

    (4) "Highly active" (leisure-time aerobic activity >300 min. per week).

    Calculations are based on self-reports of interview respondents and assume 1 minute of vigorous activity = 2 minutes of moderate physical activity

KEY VARIABLES 4:

4. Presence or Absence of <u>at</u> <u>least</u> <u>one</u>

Chronic Health Condition

Self-reported information on chronic health conditions included the presence or absence of:

(1) diabetes

(2) cancer

(3) circulatory diseases (myocardial infarction, angina, cardiovascular diseases, and stroke),

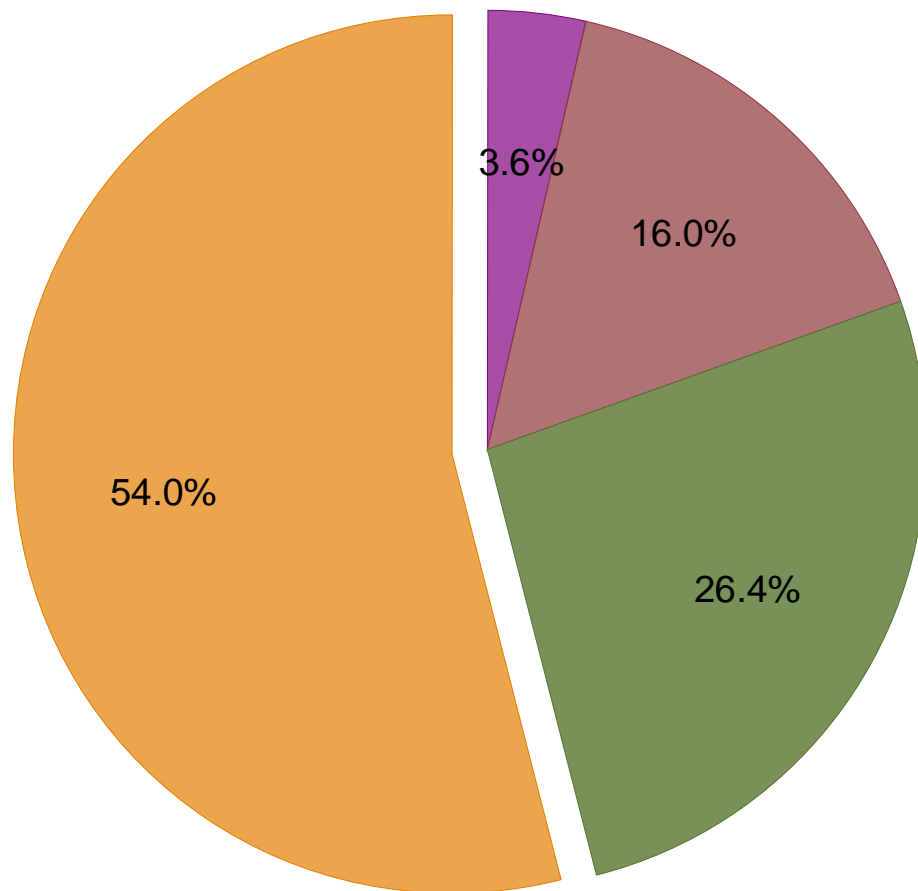(4) respiratory diseases (emphysema, asthma, and chronic bronchitis)

(5) functional limitations (any difficulty with walking, climbing steps, standing, sitting, stooping, reaching, grasping, and lifting, pushing or pulling large objects)

CONFOUNDING/CONTROL VARIABLES

1. Age
2. Sex
3. Race/ethnicity (NH White, NH Black, Asian, Hispanics)
4. Education (<HS, HS, Some Coll., B.S./B.A., Graduate Degree
5. Poverty (<100%, 100%<200%, 200%+)
6. Health Insurance (Medicare, Medicaid, Private, Other Government Insurance)
7. BMI calculated from self-reported height and weight measures with a use of a correction factor (Stommel & Schoenborn, 2009)
8. Smoking status: never smoked, former smoker, current smoker
9. Alcohol Consumption: life-time abstainer (<12 drinks in entire life), former drinker (no drink in past year), current moderate drinker, current heavy drinker (>2 drinks per day (men) or> 1 drink per day (women)

Percent of U.S. Population Meeting DHHS 2008 Physical Activity Guidelines
Averaged Population Estimates for 1997-2004

- 3.6%
- 16.0%
- 26.4%
- 54.0%

Legend:
- meets strengthening rec's only
- meets aerobic&strengthening rec's
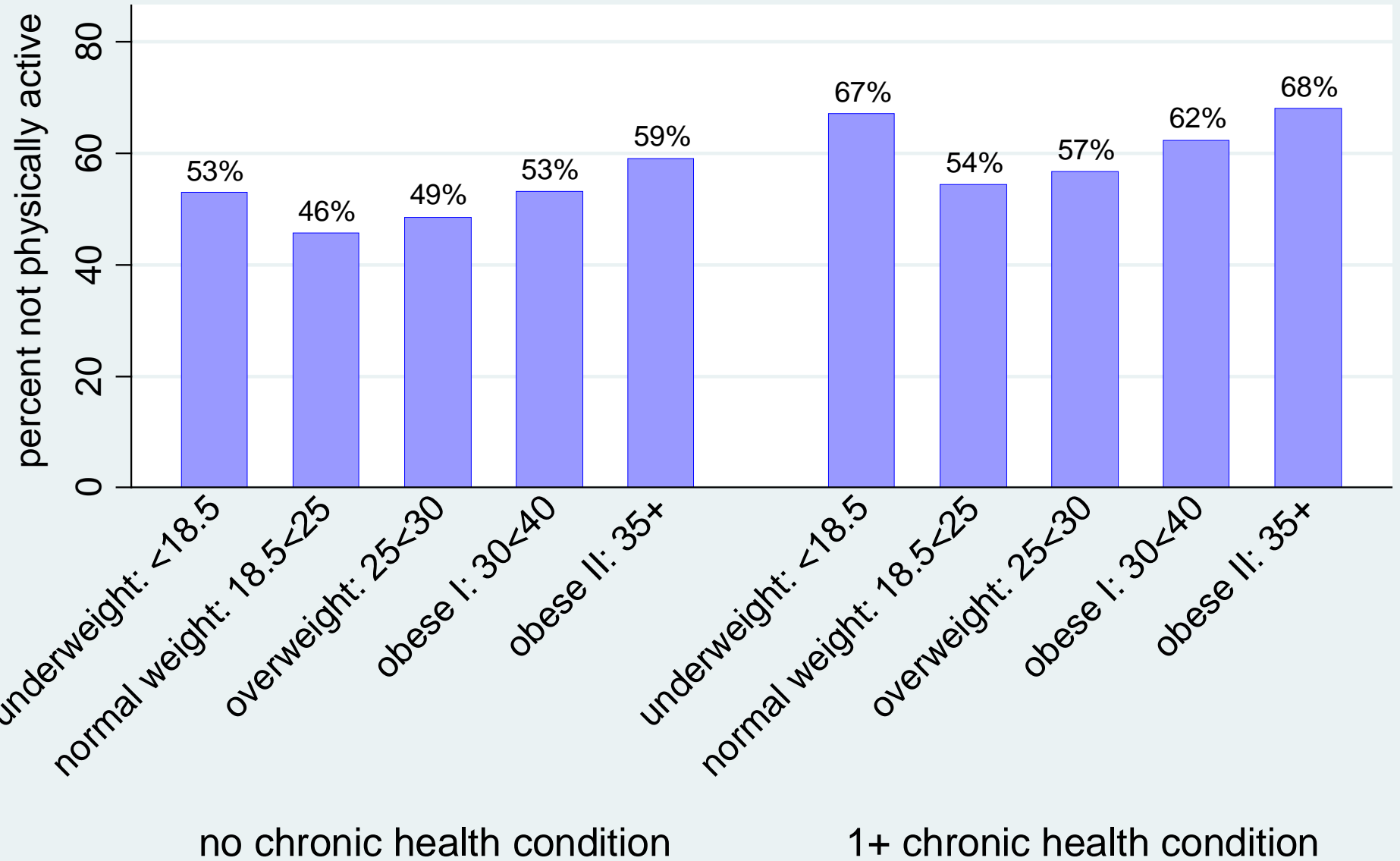- meets aerobic rec's only
- meets neither recommendations

Physically INactive U.S. Population BY Age Group and Chronic Conditions
Averaged Population Estimates for 1997-2004
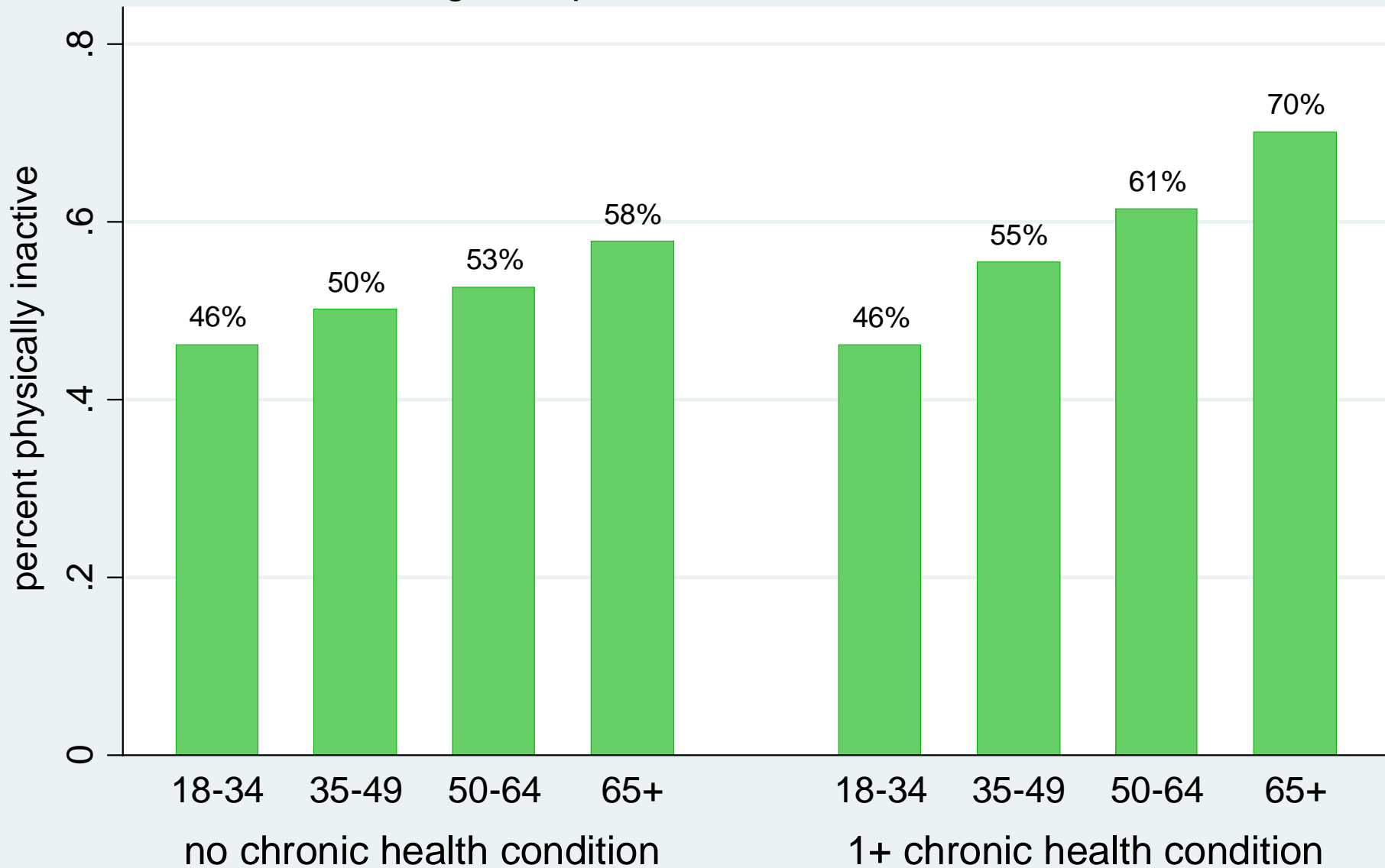
Physically INactive U.S. Population BY BMI Category and Chronic Conditions

Averaged Population Estimates for 1997-2004

Bar chart. Y-axis: "percent not physically active" (0 to 80).

no chronic health condition
- underweight: <18.5 — 53%
- normal weight: 18.5<25 — 46%
- overweight: 25<30 — 49%
- obese I: 30<40 — 53%
- obese II: 35+ — 59%

1+ chronic health condition
- underweight: <18.5 — 67%
- normal weight: 18.5<25 — 54%
- overweight: 25<30 — 57%
- obese I: 30<40 — 62%
- obese II: 35+ — 68%

Physically INactive U.S. Population BY Age Group and Sex
Averaged Population Estimates for 1997-2004
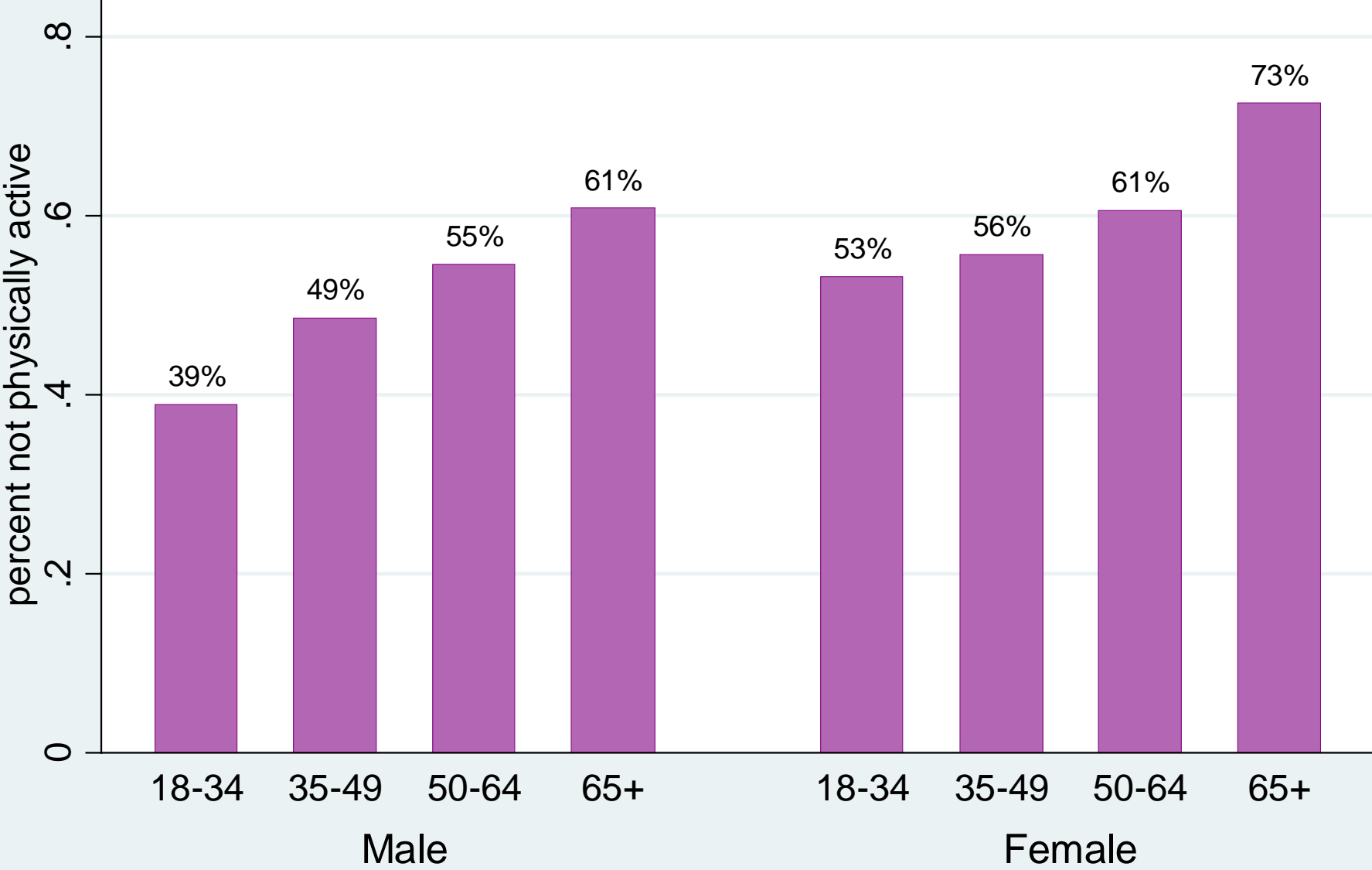
Physically INactive U.S. Population BY Race/Ethnicity and Sex
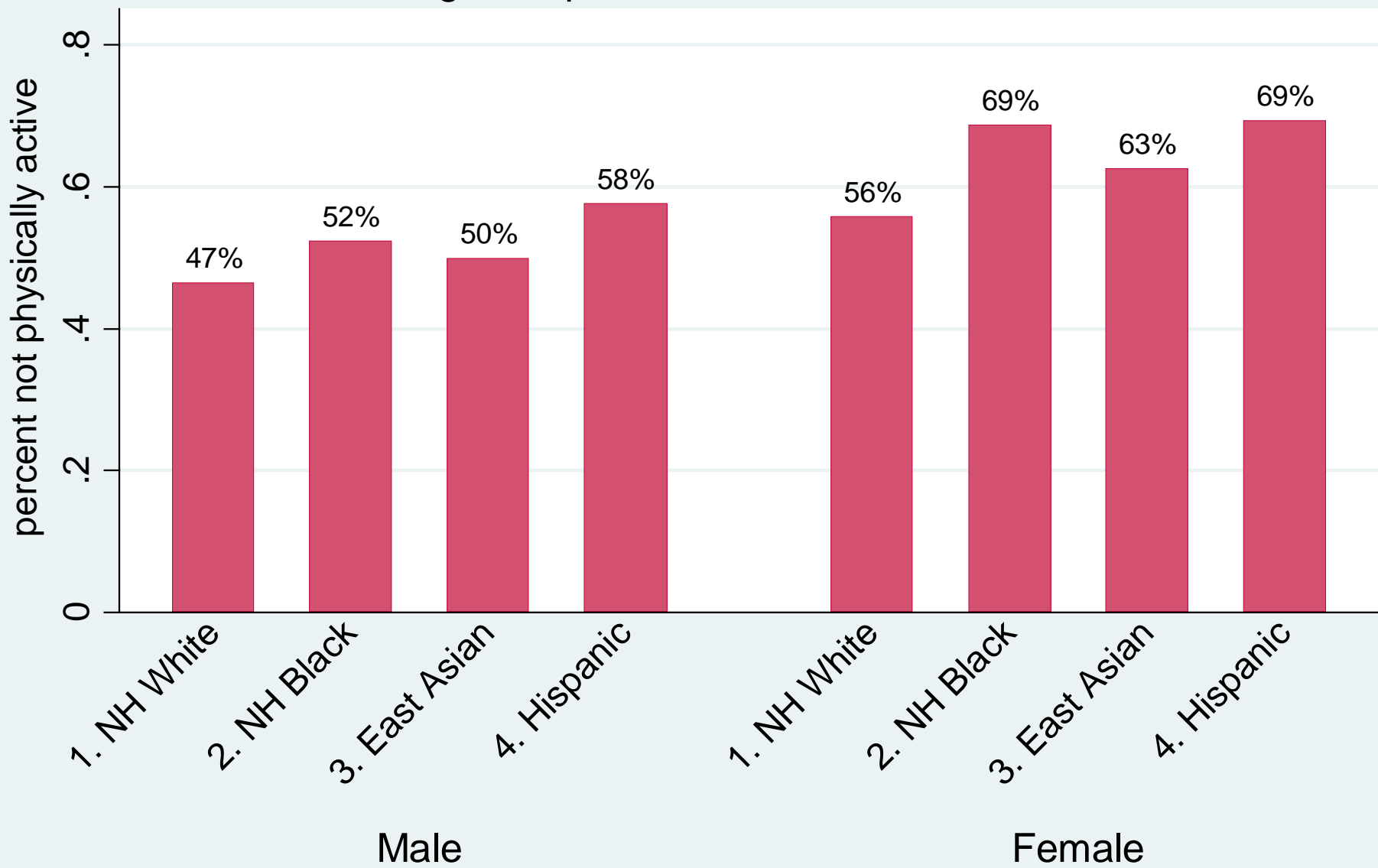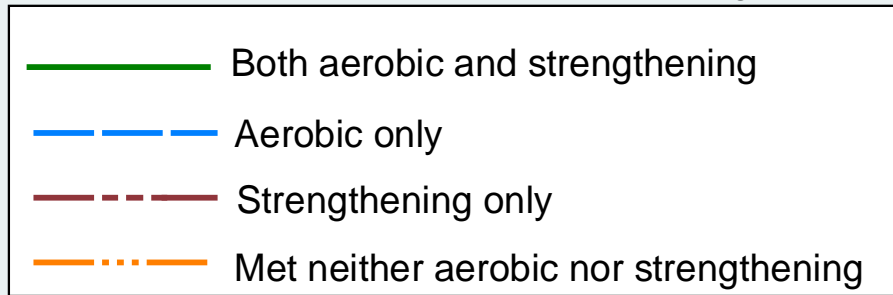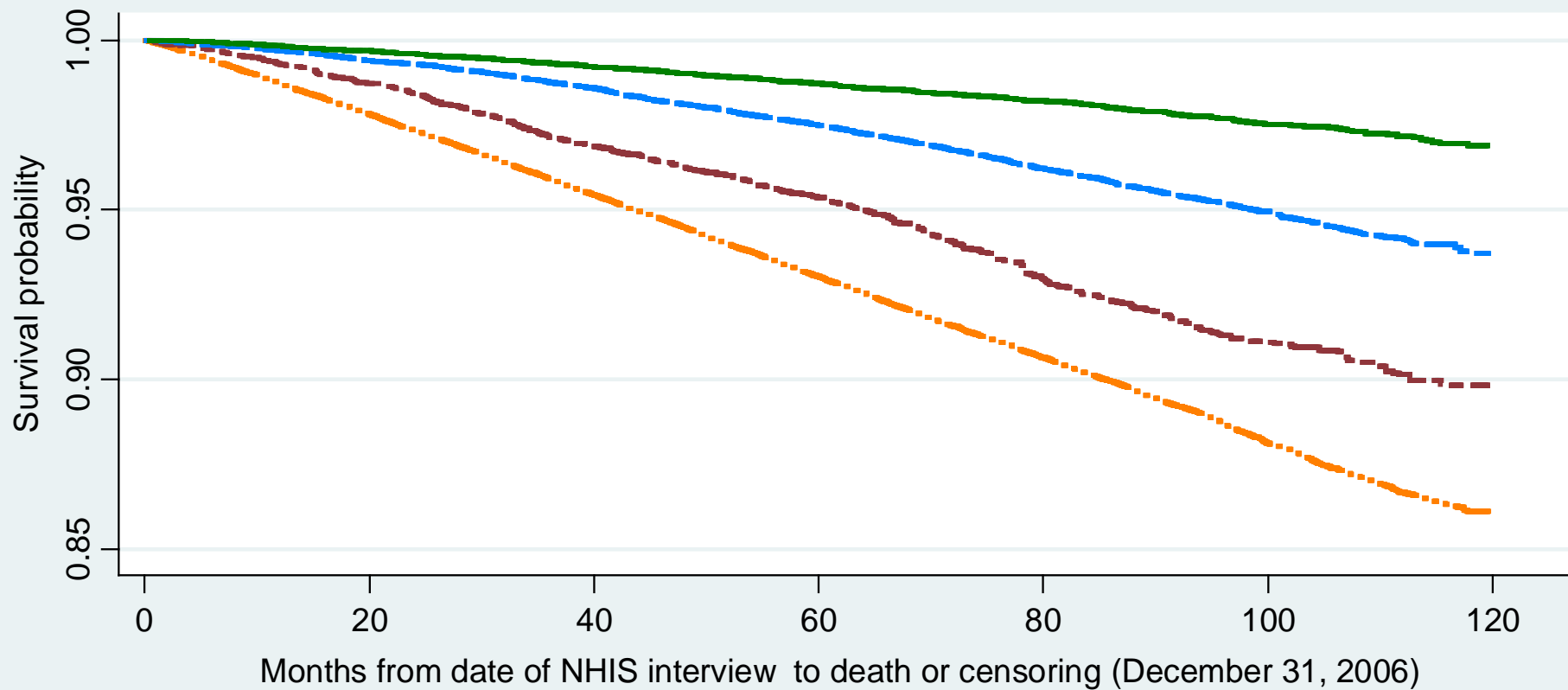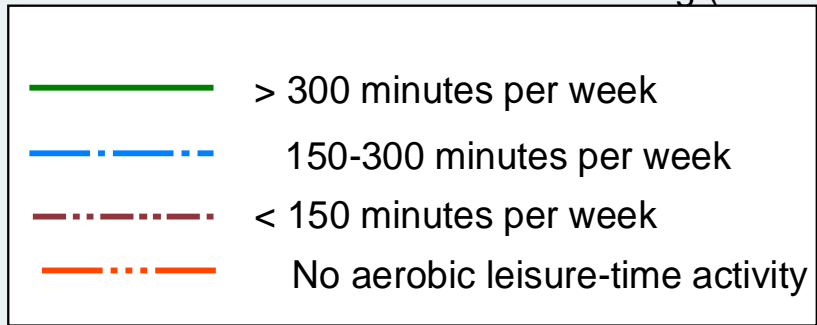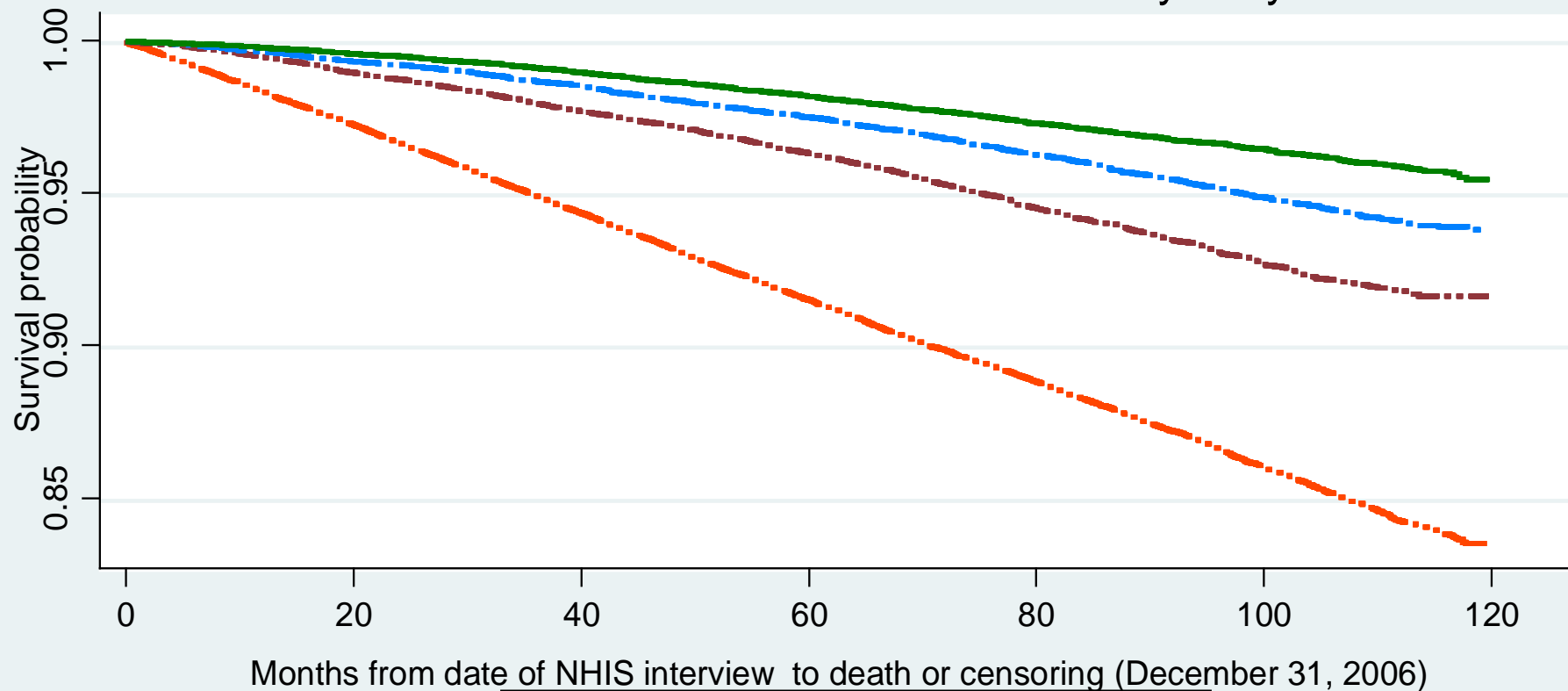Averaged Population Estimates for 1997-2004

Figure 1. Survival Probabilities by Levels of Adherence to 2008 PA Guidelines

Note: U.S. adults aged 18 years and over (weighted). National Health Interview Survey (NHIS), 1997-2004

Figure 2. Survival Probabilities by Levels of Leisure-Time Aerobic Activity Only

Note: U.S. adults aged 18 years and over (weighted). National Health Interview Suvey (NHIS), 1997-2004

Patterns of Mortality Hazards Associated with Co-variables
in Cox Proportional Hazard Models:

- **Sex:**
- Women have lower mortality risks: HR=0.63

- **Race/Ethnicity:**
- Compared to NH Whites, mortality risk are:
  NH Blacks: HR=1.09, Asians: HR=0.48,
  Hispanics: HR=0.75

- **Education:**
- Mortality hazards decline with more formal education:
  HR=0.76 (college graduate vs. <high school graduate)

Patterns of Mortality Hazards Associated with Co-variables
in Cox Proportional Hazard Models:

- ## Poverty status:

- Lower Mortality Risks for Higher-Income Individuals: HR=0.83 (>200% poverty level vs. <100% poverty level)

- ## Health Insurance Status:

- Compared to persons without health insurance, mortality risks are as follows: Medicare HR=1.8, Medicaid: HR=1.35; Private Insurance: HR=0.94

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- ## BMI:

- U-shaped relationship between BMI and mortality hazard with lowest hazard at 30<BMI<32 and highest hazards at BMI<18.5

Patterns of Mortality Hazards Associated with Co-variables
in Cox Proportional Hazard Models:

- ### Smoking:
- Compared to lifetime non-smokers, former smokers have greater mortality risks: HR=1.26, current smokers have the highest risks: HR=1.47

- ### Consumption of alcohol:
- Compared to life-long abstainers, former drinkers have higher mortality risks: HR=1.1, current <u>moderate</u> drinkers have lowest mortality risks: HR=0.76 and current <u>heavy</u> drinkers have same risks: HR=1.03 *ns

All-Cause Mortality Hazards Associated with 2008 Physical Activity Guidelines Recommendations: U.S. Adults (NHIS 1997-2004 Survey Data with NDI Follow-up to 12/31/2006):

	Has one or more chronic health condition		Has no chronic health condition	
Meets…	HR	95%CI	HR	95%CI
neither recommendation	1.00	Reference category	1.00	Reference category
strength rec. only not sig.	0.88	0.80-0.98	0.90	0.65-1.24
aerobic rec. only sig.	0.53	0.49-0.55	0.76	0.69-0.84
Both recommendations sig.	0.42	0.38-0.47	0.58	0.49-0.68
Cox Proportional Hazards models: Model controls for covariates: sex, race/ethnicity, education, poverty status, health insurance status, BMI, smoking, consumption of alcohol, and presence/absence of selected chronic health conditions.				

All-Cause Mortality Hazards Associated with Aerobic Activity Guidelines Recommendations: U.S. Adults (NHIS 1997-2004 Survey Data with NDI Follow-up to 12/31/2006):

	Has one or more chronic health condition		Has no chronic health condition	
	HR	95%CI	HR	95%CI
No aerobic leisure-time activity	1.00	Reference category	1.00	Reference category
<150 min. per week [sig.]	0.67	0.63-0.71	0.78	0.68-0.89
150-300 min. per week [sig.]	0.52	0.48-0.56	0.72	0.62-0.82
>300 min. per week [sig.]	0.40	0.38-0.43	0.62	0.55-0.69
Cox Proportional Hazards models: Model controls for covariates: sex, race/ethnicity, education, poverty status, health insurance status, BMI, smoking, consumption of alcohol, and presence/absence of selected chronic health conditions.				

Discussion:

Adherence to the levels of physical activity recommended in the *2008 Physical Activity Guidelines for Adults* appear to have substantial survival benefits:

1. All-cause mortality risks are lower by more than 40% among persons without existing chronic co-morbidities, and by more than half among persons with chronic co-morbid conditions.

2. Even though overall mortality risks are lower among persons without chronic conditions, those with chronic conditions have more to gain from meeting the 2008 PA recommendations

Limitations:

1. The analysis as shown did not exclude persons with functional limitations.

2. Restricting the analysis to adults who had at least one chronic condition, but no functional limitations at the time of interview, i.e., excluding cases, whose functional limitations may be the result of their closeness to death ("reverse causation"), revealed somewhat weaker hazard ratios, but adults who met the Guidelines remained at lower risk of dying than those who did not.

3. Reliance on self-reported leisure-time physical activity may well lead to an overestimate of actual physical activity due to socially desirable responses.

Limitations:

4. The calculations of overall leisure-time physical activity are based on the 2008 Physical Activity Guidelines for Americans which employs a conversion factor of 1 minute of vigorous activity = 2 minutes of moderate physical activity.

- The ratio of vigorous to moderate physical varies systematically with (1) the BMI, and (2) age.

Relative Time Spent on Vigorous & Moderate Leisure Time Activity
BY BMI Categories
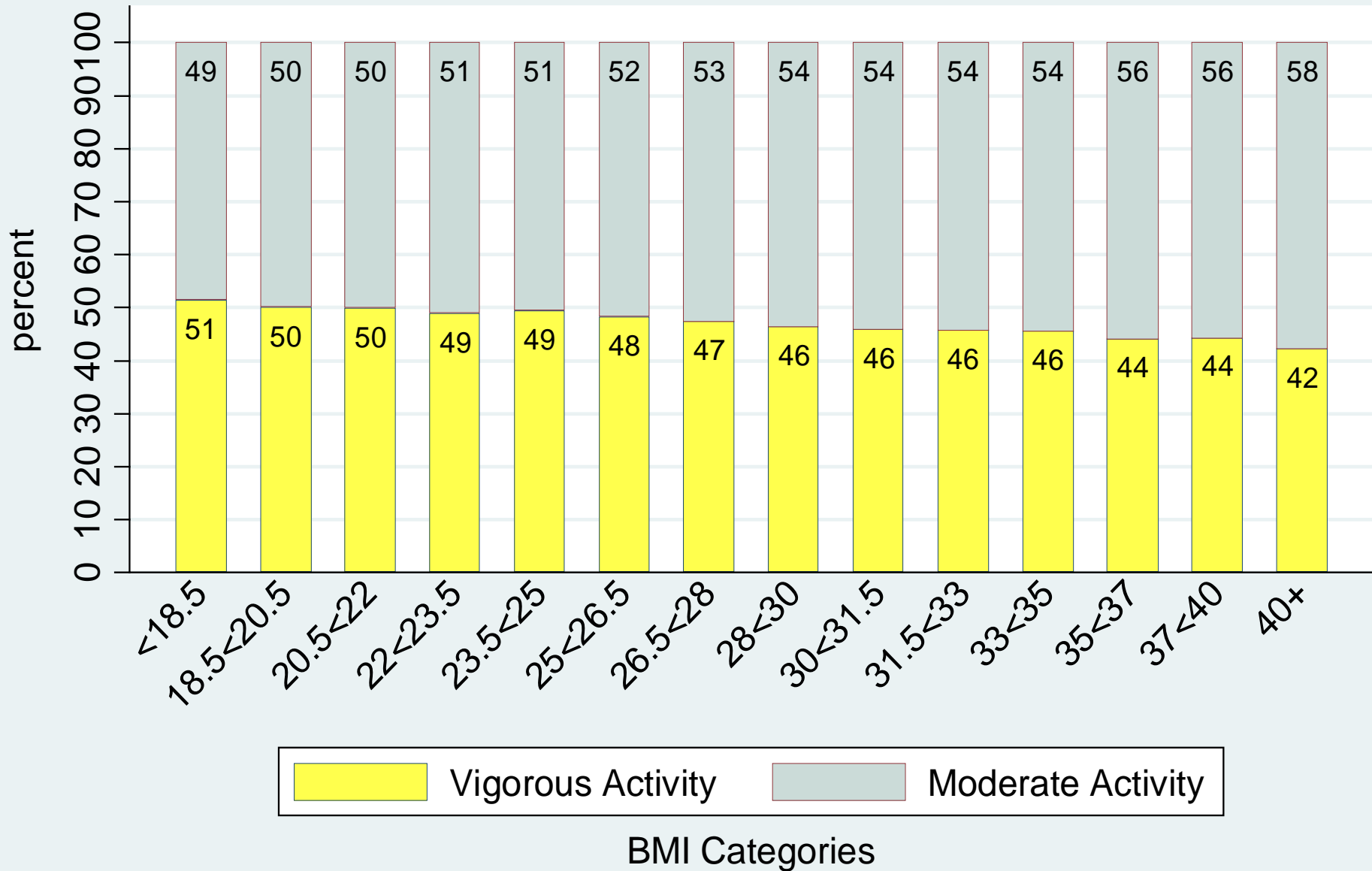
Relative Time Spent on Vigorous & Moderate Leisure Time Activity

BY Age Groups