8-10-2009

Prevalence of Overweight Resident Physicians and Year of Training

Maya Roberts

Prevalence of Overweight Resident Physicians and Year of Training

A Thesis Submitted to the
Yale University School of Medicine
in Partial Fulfillment of the Requirements for the
Degree of Doctor of Medicine

by

Maya Roberts

2009

ABSTRACT

PREVALENCE OF OVERWEIGHT RESIDENT PHYSICIANS AND YEAR OF TRAINING

Maya Roberts, Mark R. Zonfrillo, Division of Emergency Medicine, Children's Hospital of Philadelphia, Philadelphia, PA, James Dziura and Sunkyung Yu, Yale Center for Clinical Investigation, New Haven, CT, and David Spiro, Department of Emergency Medicine and Pediatrics, Oregon Health & Sciences University, Portland, OR. (Sponsored by Howard Pearson, Department of Pediatrics, Yale University School of Medicine).

Post-graduate clinical training has numerous implications for the health of resident physicians. The primary goal of this study is to monitor the health of resident physicians by year of training through measurement of body mass index (BMI), blood pressure (BP), and health-related behaviors.

This is a cross-sectional study of 375 resident physicians and longitudinal follow-up of 93 of the resident physicians at two training centers. Resident physicians were enrolled at the onset of each post-graduate year (PGY) of training in 2006, 2007, and 2008. BMI and BP were measured, and questionnaires on eating habits and physical activity were administered. Controls from the National Health and Nutrition Examination Survey (NHANES) were selected using 1:1 matching for age, gender, ethnicity, and years of education.

A greater percentage of resident physicians were overweight (BMI $\geq$ 25) at the beginning of PGY3 than at PGY1 (49% versus 30%, OR 2.26, 95% CI 1.19-4.28, P=0.01). Longitudinally enrolled resident physicians were more likely to be overweight at PGY3 than at PGY1 (OR 2.32, 95% CI 1.17-4.62, P=0.02). The average diastolic BP of resident physicians was higher at PGY3 than at PGY1 (79.7 (SE 1.32) versus 76.8 (SE 0.79), P=0.04).

Eating habits and physical activities were not mediators of change in BMI. However, there were several significant trends. Overweight resident physicians were more likely to have high-risk eating habits than non-overweight resident physicians. Nearly half of overweight resident physicians (43%) described themselves as "normal weight." The mean BMI of resident physicians was lower than that of matched controls on entering residency, but the magnitude of this difference decreased significantly by program year (P for interaction=0.02).

Post-graduate clinical training appears to be associated with an increased prevalence of overweight status among resident physicians.

ACKNOWLEDGEMENTS

It is my great honor to express my gratitude:

To David Spiro, MD, MPH – This thesis would not exist without your once-in-a-lifetime mentorship. You encouraged me to excel in our expectations in pursuing the truth.

To Mark Zonfrillo, MD – Your mentorship, wisdom, and constant push forward are rare gifts equaled only by the tremendous value of our friendship.

To James Dziura, PhD and Sunkyung Yu, MS – Your commitment to excellence and patience with interesting data is what makes this thesis great.

To John Forrest, MD, and the Office of Student Research – This thesis was executed with repeated generous financial support through research fellowship.

To Kirsten Bechtel, MD and Howard Pearson, MD – Your commitment as an impromptu primary investigator and thesis advisor, respectively, exceeds any expectations.

To Program Directors, Coordinators, and to the Resident Physicians at YNHH and OHSU- Your open support, flexibility, and encouragement made recruitment a resounding success.

To the Research Assistants: Neil, Jen, Joe, Jenny, Marilee, Rana, Ashley, Michelle, Bei Bei, and Michael – You were committed to uphold the high standards of clinical research.

To my parents, Michele Roberts, MD, PhD, and Jeremy Golding, MD, my grandmother, Rene Roberts, and my sisters, Eliana Tair Roberts Golding and Yona Tali Roberts Golding – Your unwavering love and dedication made this entire journey possible.

To my ben zug, Uri Leventer, MPP– Your stellar reviewing of drafts is second only to your unparalleled role of support.

Thank you.

TABLE OF CONTENTS

INTRODUCTION

Obesity is a growing national and global epidemic,[1-3] and an independent risk factor for a number of chronic diseases, including heart disease, diabetes, high cholesterol, high blood pressure, gall bladder disease, and osteoarthritis as well as decreased quality of life.[4-9] In 2005, one study concluded that obesity reduces an individual's life expectancy as well as the average life expectancy in the United States, which is predicted to decline for the first time.[5, 7, 10] Obesity can be measured through several methods, including measuring body mass index (BMI), skin folds, bioelectrical impedance, and hydrostatic measurement. Measured BMI has been validated as a tool for measuring obesity in an individual for the purposes of estimating body fat percentage and predicting health risks.[11, 12]

Hypertension is also an independent risk factor for a number of diseases, including cardiovascular disease and renal failure.[13, 14] Studies show that adults have an association between obesity and increased rates of hypertension, including physicians who have a high level of education and a high level of income.[15, 16]

Both BMI and BP are associated with a number of factors, including age, gender, race, and years of education.[3] They are also affected by modifiable risk factors including physical activity and eating habits.[17-19] In order to understand the etiology of abnormal BMI and BP or of progressive changes, it is important to consider the input of measurable risk factors.

Despite the fact that obesity and hypertension are of concerns for Americans of all backgrounds and education levels, little is known about the physical health of resident

physicians during their clinical training, especially related to their increased stress levels, work load, and sleep deprivation. The recent 80 hour work-week regulation has inspired numerous studies documenting the resulting changes in trainees' experiences and patient outcomes,[20] including reduced net hours in the hospital[21] and challenges faced in the transfer of patient care.[22] Studies have documented the effects of sleep-deprivation, including decreased learning of new materials, increased medical errors in task performance, increased weight gain, and decreased personal and occupational satisfaction.[23-30] Despite the mandated change in working hours, many resident physicians still experience sleepiness that inhibits their work performance including increasing their rates of medical errors.[31, 32] While several studies have documented increased levels of stress hormones, decreased psychological wellbeing, and decreased work satisfaction,[30, 33, 34] no study has examined the overall physical health of resident physicians during training.

The physical health of resident physicians is a critical component of medical education because it has the potential to affect the quality of trainee performance, the effectiveness of training, and long-term health outcomes.[35-37] Several studies have indicated that clinical outcomes of patients can be related to the physical health of the physician; one study found that only 42% of obese patients were advised by their physician to lose weight, and that those who were advised to try to lose weight were more likely to make behavior changes.[38, 39] In addition, physicians who maintain a healthier lifestyle are most likely to provide accurate and consistent prevention counseling.[40] Furthermore, obese patients are significantly more likely to express confidence in the counseling and treatment provided by non-obese physicians.[41] Patients are significantly

more motivated to lose weight if their physicians disclose their own personal habits and discuss diet and physical activity. In one study, physicians were rated to be more believable in their patient interactions if they disclosed a number of their own habits, such as riding their bike to work and diet changing strategies.[41, 42]

There is a history of insufficient medical training in assessing BMI. There is also an association between the emphasis during training and the subsequent outcomes in practice. Medical students do not have sufficient knowledge about BMI as a measurement, as a risk factor, or as an opportunity to provide effective prevention counseling.[43] However, medical students are more likely to provide nutrition and physical activity counseling to patients if the medical students attend institutions that encourage pursuing health maintenance such as healthy eating and physical activity.[44] Resident physicians have insufficient preparation for identifying overweight and obese patients.[35] Numerous studies have also indicated that resident physicians are inadequately prepared and insufficiently motivated to counsel patients they recognize as overweight or obese.[45-48] It is reasonable to hypothesize that this lack of identification and counseling can apply both to how resident physicians perceive their patients' weight and to how they perceive their own weight.

Medical professionals do not have a strong record for management of their own health maintenance. A low percentage of physicians have healthy personal health practices, particularly in their use of vaccines and cancer screening. One study found that only 34% had a primary care physician.[44, 49-52] Previous studies also have indicated high rates of burn out and dissatisfaction with both work and personal environment.[29, 33, 34] While physicians' mortality from diseases treatable by medical intervention is lower than

that of the general population, their overall mortality rates are not significantly different.[52] One study found that even among resident physicians with treatable chronic conditions, fewer than half of them have a primary care provider.[53]

Furthermore, studies have found a significant percentage of medical students to be overweight and with risky behaviors; 10% of medical students have admitted to intermittent smoking, and 14% of women had never had a pelvic exam.[44, 54, 55] The percentage of medical students who believed that nutrition and nutrition counseling is important in their training declined over the course of training, and is also related to their commitment and knowledge of counseling practices.[56]

Medical education is not the only field in which studies find changes in rates of weight gain. Numerous studies detailing the weight gain upon entering undergraduate education suggest that worsening health status is also likely for resident physicians given similar changes in environment, resources, and ambient stress level.[11, 57-60] These studies focus primarily on the changes that occur in BMI, eating habits, and physical activity in the first two years of education. However, educational interventions such as lecture series and available resources have been shown to reduce the body mass gain in these subjects.[61]

There is a significant documentation of the risks of obesity and the association between weight gain and higher education. Resident physicians are at high risk of inadequately maintaining their healthy practices due to the high demands on their personal and professional life. Changes in their personal health can be related to the quality of their training, the success of their clinical practice, and their long-term health outcomes.

STATEMENT OF PURPOSE

The purpose of this research is to determine whether there is an association between the year of training for resident physicians and progressive negative physical health measurements.

HYPOTHESIS

The hypothesis is that resident physicians have negative changes in their physical health each successive year during their post-graduate clinical training. Furthermore, this progression differs from that of controls.

AIMS

This is an observational cross-sectional and longitudinal study of the physical health of a cohort of resident physicians over the course of training. The primary goal is to assess the health of resident physicians by year of training as indicated by the outcome measures of BMI, BP, eating habits, physical activity, and self-described weight status. The secondary goal is to determine whether resident physicians were more likely than matched controls to demonstrate physical changes. We considered the site of training, the enrolled program of study, and the year of training to be the exposures.

The outcomes and exposures met at least one of the following characteristics: they were obtainable easily and efficiently, they could be verified through secondary means,

or they were previously validated through prior studies. This research aimed to collect a small amount of quantitative data on each of a large number of resident physicians in order to maximize the breadth of resident physicians enrolled.

METHODS

Study Design

Our study was a prospective study with a primary cross-sectional cohort and a secondary longitudinal cohort based on three data collection points: onset of PGY in 2006, 2007, and 2008. We trained research assistants to measure height, weight, BP, and to collect self-reported surveys. Resident physicians were approached at scheduled events during intern orientation, continuity clinics, and scheduled lecture series. Previously enrolled resident physicians received individual email invitations to schedule re-measurements.

Participants

Participants were recruited from among the resident physicians in the Departments of Emergency Medicine, Internal Medicine, Obstetrics and Gynecology, Pediatrics, Primary Care, Psychiatry, and Surgery at Yale New Haven Hospital (YNHH), New Haven, CT, and from the Departments of Family Medicine, Internal Medicine, Obstetrics and Gynecology, Pediatrics, and Surgery at the Oregon Health & Sciences University (OHSU), Portland, OR. Resident physicians entering PGY1-3 were eligible to enroll. Resident physicians were approached to be re-measured in each successive year of the study. Resident physicians currently pregnant or who became pregnant during the course of the study were excluded.

Resident physicians were told that the purpose of the study was to document health status over the course of their training, and that their participation was voluntary and confidential. Resident physicians were provided written informed consent and HIPAA privacy agreement authorization. They did not receive any compensation for successful completion of the study, and were informed they could withdraw at any time. Institutional Review Boards approved the study at both participating centers.

Outcome Measures

Physical outcome measures were BMI and BP. BMI was calculated as weight in kilograms divided by height in meters, squared ($kg \div m^2$), with overweight defined as BMI $\geq$ 25.[1] BP was measured, with hypertension defined as systolic BP $\geq$140 or a diastolic BP $\geq$90.

Eating habits were assessed using a 16-item questionnaire that was validated for clinical decision-making (Figure 2). This survey is a shortened version of a previously validated survey.[62, 63] The survey was designed to indicate frequency of unhealthy eating behaviors. We selected four questions that were of particular interest as they have demonstrated strong associations with weight gain: eating at sit-down restaurants, eating high fat snack food, eating high sugar snack food, and drinking sugar sweetened beverages.

Physical activity was determined using a two-question validated questionnaire (Figure 3). This was selected to demonstrate basic physical activity and to monitor changes that were sufficiently different to have an effect on physical health. The

questions queried both mild and moderate exercise, and were scored based on frequency. A frequency of one or fewer times per week of either mild or moderate exercise resulted in a scoring of inadequate total physical activity.[64]

Data Collection

Measurements

Resident physicians were asked to remove their white coat and shoes before being weighed, according to the modified National Health and Nutrition Examination Survey (NHANES) protocol. Weight was measured with a portable electronic scale (Taylor Lithium Electronic Scale 7004), and height was obtained with a measuring tape. After resident physicians had completed the survey while seated for five minutes, a one-time measurement of BP was obtained on the left arm of seated resident physicians using a digital self-inflating device (HEM-712C Automatic Blood Pressure Monitor).

Demographics

Resident physicians were asked to provide department affiliation, post-graduate year, age, gender, and race. Department affiliation and PGY were verified with the official residency directory. Age was listed in years, and race was categorized as Caucasian American, African American, Latin American, Asian American, or other. Resident physicians were also asked to self-describe as underweight, normal weight,

overweight, or very overweight. Given that resident physicians have approximately the same salary across programs and sites, household income was not included in the demographics.

Data Analyses

Power calculations were based on previous work of the reported weight gain during college that indicated significant and sustained changes particularly during the first two years of the study.[60] Their research demonstrated a population mean difference in BMI of 0.6 (SD +/- 1.8). With a two-sided 0.05 significance level and a power of 80%, a sample size of at least 90 resident physicians followed longitudinally would be sufficient to detect similar changes.

The baseline characteristics were compared using an analysis of variance for continuous variables and a chi-square test for trends in categorical variables. The first measurement for each resident physician enrolled was included in the cohort for the cross-sectional study.

For the primary analysis with the cross-sectional cohort, multivariate linear regression for the continuous outcomes (BMI, systolic BP, and diastolic BP) and logistic regression for the dichotomous outcomes (overweight and hypertension) were used to compare differences in outcome variables across the program years. The regression models included the main effects for program year, age at the first year, gender, race (Caucasian versus non-Caucasian), and site (YNHH versus OHSU).

For the longitudinal analysis of resident physicians who had follow-up

measurements, continuous outcomes were compared across program years adjusting for age at the first year, gender, race, and site using a mixed model repeated measures analysis[65]. Generalized Estimating Equations (GEE)[66] were used to evaluate the dichotomous outcomes of overweight status and hypertension. Similar to the cross-sectional analysis, the models included the main effects of program year and covariates. The Sobel test[67] was used to evaluate the possible mediation of the program year – health outcome association by physical activity and eating habits.

Matched controls from 2005-2006 NHANES database[51] were selected for each resident physician (1:1 matching) based on years of education, gender, race, and age using the Optimal method incorporating PROC NETFLOW from SAS.[68-70] Matching was specific to the cross-sectional analysis. A mixed model analysis for continuous and GEE for dichotomous outcomes were used to compare differences in the outcome variables between resident physicians PGY1-3 and matched controls. The program year interaction term was used to evaluate whether the groups (resident physicians versus NHANES controls) varied by year.

Outcome measures of the associations among predictors are presented as least squares means (standard errors or 95% confidence intervals) for continuous outcomes and odds ratios (95% confidence intervals) for dichotomous outcome variables. All analysis was performed using SAS Version 9.1 (SAS Institute Inc, Cary, NC), with statistical significance set at $P < .05$ using two-sided tests.

Contribution

The study concept and design were completed by Ms. Roberts, Dr. Spiro, and Dr. Zonfrillo. IRB, HIC, and grant proposals were completed by Ms. Roberts and approved by the advisor. Administrative, technical, and material support was provided by Ms. Roberts, Dr. Spiro, and Dr. Zonfrillo.

Participants were recruited primarily by the research assistants. The research assistants were recruited, trained, and monitored primarily by Ms. Roberts. Ms. Roberts also recruited several participants. Dr. Zonfrillo and Dr. Spiro also contributed to the recruitment and monitoring of research assistants.

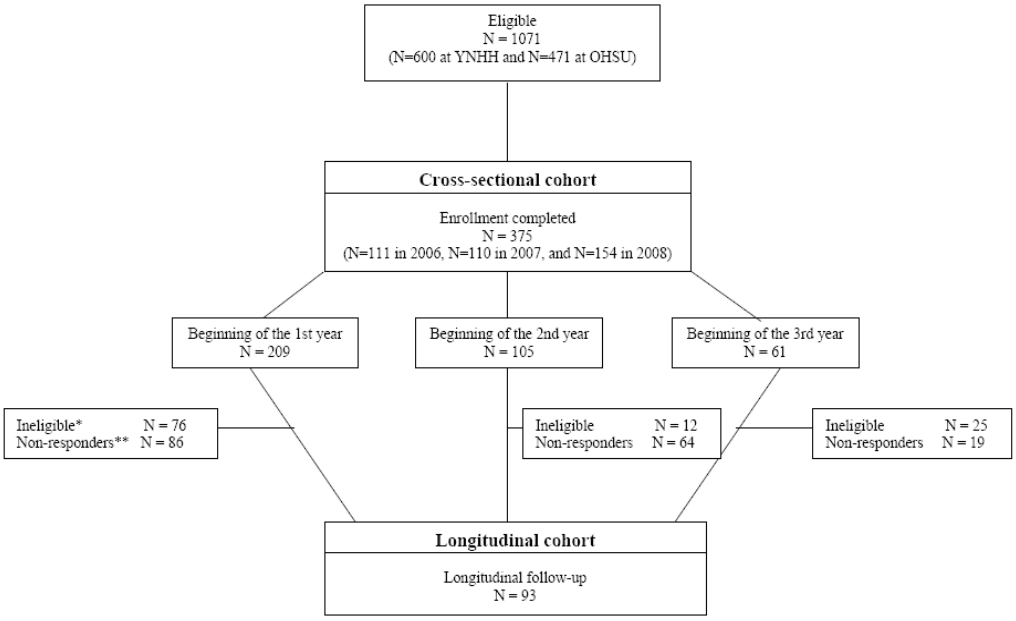
Data entry was completed entirely by Ms. Roberts. Data analysis and interpretation was completed primarily by Dr. Dziura and Ms. Yu, as part of a team lead by Ms. Roberts. Ms. Roberts presented an abstract of preliminary data as a Platform Presentation at the 2008 Pediatric Academic Societies' Annual Meeting. The manuscript submitted for publication was drafted by Ms. Roberts and edited by Ms. Yu, Dr. Spiro, Dr. Zonfrillo, and Dr. Dziura.

RESULTS

Study Population Characteristics

Of the 1071 total eligible full-time resident physicians (600 at YNHH, and 471 at OHSU) in 2006, 2007, and 2008, 111 completed the enrollment in 2006, 110 in 2007, and 154 in 2008. There were 375 resident physicians enrolled, 93 of whom were measured longitudinally in more than one year of the study (Figure 1).

Figure 1:



* Ineligible indicates pregnant, graduated, or PGY1 in 2008.
** Non-responders indicate not approached prior to 2008, not enrolled due to scheduling conflict, no reply, or refusal.

There were no significant differences in the baseline characteristics by PGY (Table 1). The majority (90%) of longitudinally enrolled resident physicians were at the YNHH site. There were no significant differences in baseline characteristics between those who did and those who did not enroll longitudinally.

Table 1. Participants' Characteristics at Each PGY

	All N=375	PGY1 N=209	PGY2 N=105	PGY3 N=61
Demographics				
Age (y)	28.6 ±[a] 3.0	28.6 ± 3.0	28.9 ± 2.9	29.4 ± 2.7
Gender				
Female	204 (54.4)[b]	102 (48.8)	62 (59.1)	40 (65.6)
Race				
Caucasian	259 (69.1)	144 (68.9)	73 (69.5)	42 (68.9)
Other	116 (30.9)	65 (31.1)	32 (30.5)	19 (31.2)
Site				
YNHH	258 (68.8)	153 (73.2)	62 (59.1)	43 (70.5)
OHSU	117 (31.2)	56 (26.8)	43 (41.0)	18 (29.5)
Clinical Outcomes				
BMI	24.1 ± 3.9	24.2 ± 3.9	23.4 ± 3.6	25.1 ± 4.2
≥ 25	125 (33.5)	71 (34.0)	27 (26.0)	27 (45.0)
Blood Pressure				
SBP	125.8 ± 15.0	125.7 ± 15.7	126.0 ± 15.1	125.8 ± 12.3
DBP	76.9 ± 9.7	76.1 ± 9.6	77.6 ± 10.4	78.7 ± 8.2
Hypertension				
SBP ≥ 140 or DSP ≥ 90	76 (20.5)	43 (20.9)	23 (21.9)	10 (17.0)
Behaviors				
Physical Activity				
Yes	206 (56.0)	117 (57.1)	50 (48.5)	39 (65.0)
Eating Habits				
Eat 4+ times/wk at restaurants	209 (56.3)	113 (54.6)	63 (60.1)	33 (55.0)
Eat high fat snack food	186 (49.6)	93 (44.5)	61 (58.1)	32 (52.5)
Eat high sugar snack food	229 (61.1)	130 (62.2)	62 (59.1)	37 (60.7)
Consume sweetened drinks	83 (22.1)	47 (22.5)	22 (21.0)	14 (23.0)
Self-Description				
Normal	266 (74.9)	151 (76.3)	75 (76.5)	40 (67.8)
Overweight	89 (25.1)	47 (23.7)	23 (23.5)	19 (32.2)

Abbreviations: PGY, Post-Graduate Year; YNHH, Yale New Haven Hospital; OHSU, Oregon Health & Sciences University; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); SBP, systolic blood pressure; DBP, diastolic blood pressure.

[a] Mean ± Standard Deviation.

[b] N (%).

When the resident physicians were subcategorized by their program of enrollment, they demonstrated statistically significant characteristics (Table 2). Surgical resident physicians (Emergency Medicine, Obstetrics/Gynecology, and General Surgery or Surgical Subspecialties) were statistically more likely than medical resident physicians (Internal Medicine, Primary care, Pediatrics, Psychiatry, or Family Medicine) to have a greater absolute weight (74kg versus 70kg, $P<0.05$), be classified as overweight (41% versus 29%, $P<0.05$), and be hypertensive (26% versus 17%, $P<0.5$). However, when controlling for demographics such as gender, race, and age, the difference in BMI no longer achieved statistical significance ($P=0.08$). Additionally, when controlling for demographics, there was no difference in rates of hypertension ($P=0.18$). Overall, the differences between surgical resident physicians and medical resident physicians could be accounted for by the differing characteristics of the sample.

The responses by resident physicians to the self-reported questionnaires on physical activity, eating habits, and self-description did not vary significantly by demographics. There were some notable variations and concerning responses. Just over half (56%) of all resident physicians obtain the minimally recommended amount of physical activity. Only 25% of resident physicians self-identify as overweight, whereas 34% of resident physicians are overweight or obese. Also, 22% of resident physicians consume sugar-sweetened beverages on a daily basis (Table 1).

Table 2. Participants' Characteristics by Program (N=375)

Characteristics		Medical (N=239)	Surgical (N=136)
Weight (kg)		**69.7 ± 14.3**	**73.9 ± 16.5**
Height (m)		1.70 ± 0.09	1.73 ± 0.11
BMI		23.82 ± 3.86	24.63 ± 3.86
Overweight	**BMI ≥ 25**	**69 (29.1)**	**56 (41.2)**
Systolic Blood Pressure (mmHg)		124.4 ± 13.5	128.3 ± 17.0
Diastolic Blood Pressure (mmHg)		76.9 ± 9.3	77.0 ± 10.2
Hypertension	**Yes (SBP ≥ 140 or DSP ≥ 90)**	**41 (17.4)**	**35 (26.1)**
Race/Ethnicity	**Caucasian American**	**175 (73.2)**	**84 (61.8)**
	Non-Caucasian American	**64 (26.8)**	**52 (38.2)**
Age (years)		**28.4 ± 2.8**	**29.04 ± 3.2**
	Age ≤ 28	**148 (61.9)**	**75 (55.2)**
	Age > 28	**91 (38.1)**	**61 (44.9)**
Site	**Yale**	**175 (73.2)**	**83 (61.0)**
	OHSU	**64 (26.8)**	**53 (39.0)**
Gender	Female	135 (56.5)	69 (50.7)

[α] Plus-minus values are Mean ± SD.
[β] Data on categorical variable is presented as number of subjects (%).
[*] Bolded P < .05, when compared resident physicians in Medical and Surgical groups.

Cross-Sectional Analysis

In the cross-sectional analysis, the average BMI was higher at PGY3 than at PGY2 or PGY1 (P<.05) when adjusted for age, gender, race, and site. Furthermore, PGY3 resident physicians were more likely to be overweight than PGY1 resident physicians (OR 2.26 95% CI 1.19-4.28 (P=0.01)) or PGY2 resident physicians (OR 2.87 95% CI 1.39 – 5.92 (P=0.005)) (Table 3). The difference between PGY1 and PGY2 did not achieve statistical significance (Table 3).

Year of program study was not associated with a different systolic BP in the cross-sectional analysis (Table 3). There was a 2.9-point difference detected in the diastolic BP in the beginning of the third compared with the beginning of the first year

(79.7 versus 76.8, *P*=0.04). While there was an upward trend of hypertension in successive training years, this did not achieve statistical significance (Table 3).

Table 3. Regression of BMI and Blood Pressure in Cross-sectional and Longitudinal cohorts[¥]

	Program year of training			Comparisons between program years		
	PGY1	PGY2	PGY3	PGY3 vs. PGY1	PGY3 vs. PGY2	PGY2 vs PGY1
Cross-sectional cohort						
Weight status						
BMI	24.1(0.29)[a]	23.8(0.37)	25.6(0.48)	**1.47(0.45,2.48)**[b]	**1.83(0.70,2.95)**	-0.36(-1.20,0.48)
Overweight BMI ≥ 25	0.30(0.22,0.39)[c]	0.25 (0.17,0.35)	0.49 (0.34,0.64)	**2.26(1.19,4.28)**[d]	**2.87(1.39,5.92)**	0.79(0.45,1.38)
Blood Pressure						
SBP	126.1(1.10)	127.3(1.40)	128.2(1.84)	2.04(-1.87,5.95)	0.82(-3.48,5.12)	1.22(-1.98,4.42)
DBP	76.8(0.79)	78.5(1.00)	79.7(1.32)	**2.88(0.08,5.68)**	1.15(-1.92,4.23)	1.73(-0.56,4.02)
Hypertension SBP≥140orDSP≥90	0.22 (0.15,0.30)	0.25 (0.16,0.37)	0.21 (0.12,0.35)	0.92(0.41,2.06)	0.78(0.32,1.86)	1.19(0.64,2.19)
Longitudinal cohort						
Weight status						
BMI	23.4(0.59)	23.7(0.56)	23.9(0.58)	0.42(-0.23,1.07)	0.18(-0.31,0.68)	0.24(-0.23,0.71)
Overweight BMI ≥ 25	0.12 (0.06,0.24)	0.19(0.10,0.36)	0.24 (0.12,0.43)	**2.32(1.17,4.62)**	1.28(0.70,2.35)	**1.82(1.07,3.11)**
Blood Pressure						
SBP	126.3(2.20)	124.4(1.97)	123.9(2.12)	-2.46(-6.11,1.18)	-0.56(-3.46,2.35)	-1.91(-4.81,1.00)
DBP	78.1(1.88)	79.2(1.65)	78.7(1.80)	0.62(-2.70,3.95)	-0.47(-3.18,2.23)	1.10(-1.65,3.84)
Hypertension SBP≥140 or DSP≥90	0.11 (0.04,0.19)	0.10(0.05,0.21)	0.19 (0.09,0.35)	1.95(0.80,4.77)	2.05(0.82,5.09)	0.96(0.34,2.67)

Abbreviations: PGY, Post-Graduate Year; YNHH, Yale New Haven Hospital; OHSU, Oregon Health & Sciences University; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); SBP, systolic blood pressure; DBP, diastolic blood pressure.
Bolded indicates statistical significance.
[a] Least Squares Mean (Standard Error). [b] Difference of Least Squares Mean (95% Confidence Interval of Difference of Least Squares Mean).
[c] Adjusted proportion from the model (95% Confidence Interval of the adjusted proportion). [d] Odds Ratio (95% Confidence Interval of Odds Ratio).
[¥] Adjusted by age at the first year of program year, gender, race, and site.

Physical activity, eating habits, and self-descriptions did not significantly vary by program year, nor did they mediate health outcomes. However, we investigated the characteristics of the overweight versus normal-weight resident physicians in order to determine whether there were any significant patterns unrelated to the weight gain. Overweight resident physicians were more likely than normal-weight resident physicians to often or sometimes eat at sit-down restaurants (67% versus 51%, *P*=0.002) and to consume non-diet flavored drinks (29% reporting often or sometimes versus ever 19%,

P=0.02). Overweight resident physicians were also more likely than normal-weight resident physicians to describe themselves as "overweight" (57% versus 9.0%, *P*<0.001), although nearly half (43%) still described themselves as "normal weight," as opposed to 91% of normal-weight physicians who described themselves as "normal weight" (Table 4).

Table 4. Participants' REAP, Physical activity, and Self-description by Overweight/Non-overweight (N=375)

Characteristics		Overweight (BMI ≥ 25) (N=125)	Non-overweight (BMI < 25) (N=248)	Overall (N=373[#])
REAP2	**Usually/Often**	**36 (29.2)**	**50 (20.3)**	**86 (23.3)**
	Sometimes	**47 (38.1)**	**75 (30.5)**	**122 (33.1)**
	Rarely/Never	**40 (32.5)**	**121 (49.2)**	**161 (43.6)**
REAP10	Usually/Often	14 (11.2)	22 (8.9)	36 (9.7)
	Sometimes	45 (36.0)	105 (42.3)	150 (40.2)
	Rarely/Never	66 (52.8)	121 (48.8)	187 (50.1)
REAP12	Usually/Often	25 (20.0)	38 (15.3)	63 (16.9)
	Sometimes	53 (42.4)	112 (45.2)	165 (44.2)
	Rarely/Never	47 (37.6)	98 (39.5)	145 (38.9)
REAP13	**Usually/Often**	**17 (13.6)**	**22 (8.9)**	**39 (10.5)**
	Sometimes	**19 (15.2)**	**24 (9.7)**	**43 (11.5)**
	Rarely/Never	**89 (71.20)**	**202 (81.5)**	**291 (78.0)**
Physical activity	Yes	74 (61.2)	131 (53.47)	205 (56.0)
	No	47 (38.8)	114 (46.53)	161 (44.0)
Self-Description	**Normal**	**52 (43.3)**	**212 (91.0)**	**264 (74.8)**
	Overweight	**68 (56.7)**	**21 (9.0)**	**89 (25.2)**

[#] Two subjects do not have weight or height measurements.

[β] Data on categorical variable is presented as number of subjects (column %).

[*] Bolded P-value < 0.05 from a trend test for the REAP questionnaire and a chi-square test for the Physical activity and self-description

[§] REAP Q2: Eat 4 or more meals from sit-down or take out restaurants? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never

REAP Q10: Eat regular potato chips, nacho chips, corn chips, crackers, regular popcorn, nuts? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never

REAP Q12: Eat sweets more than 2 times per day? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never

REAP Q13: Drink 16 ounces or more of non-diet soda, fruit drink/punch or Kool-Aid day? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never

Longitudinal Analysis

In the cohort of resident physicians who were measured more than once, adjusted for age, gender, race, and site, the mean BMI was not different across each of the three years of training (*P*=0.23). However, the percent of resident physicians who were overweight increased significantly over the course of training. At PGY3, resident physicians were more likely to be overweight than they were at PGY1 (OR 2.32 95% CI 1.17-4.62, (*P*=0.02)) (Table 2). Resident physicians in PGY2 were also more likely to be overweight than they were in PGY1 (OR 1.82 95% CI 1.07 – 3.11 (*P*=0.03)). The likelihood of being overweight was not statistically different in the longitudinal population between PGY2 and PGY3 (OR 1.28 95% CI 0.70 – 2.35, (*P*=0.43)).

PGY was not associated with an increase in systolic or diastolic BP in the longitudinal analysis. There was insufficient evidence to support an interaction between an increased prevalence of hypertension across the years of post-graduate training (Table 3). Physical activity, eating habits, and self-descriptions did not significantly vary with program year in the longitudinal cohort. Eating habits also did not vary significantly with program year among those that gained weight (N=43).

Furthermore, there were no significant differences in outcomes among those resident physicians who were enrolled longitudinally and those who were eligible to be enrolled but were only measured once and included in the cross-sectional analysis.

Matched Control Analysis

Average BMI was lower for the resident physician group than for the control group across all three data points (24.2 for PGY1 resident physicians versus 27.9 for the control group (P<0.001), 23.4 for PGY2 resident physicians, versus 27.4 (P<0.001), 25.1 for the PGY3 resident physicians versus 26.1 (P<0.3)) (Table 4). However, the BMI difference significantly decreased from 3.8 at PGY1 to 1.0 at PGY3 (P=0.02). Thus, the likelihood of being overweight in the controls was not significantly different from the PGY3 resident physicians (OR=0.67, 95% CI 0.33–1.34, (P=0.3)), but it was significantly different in PGY1 (OR=0.28, 95% CI 0.19-0.41, (P<0.001)) and in PGY2 (OR=0.27, 95% CI 0.15-0.48, (P=<0.001)) (Table 4).

Table 4. Comparison of Resident physician and Matched Control[a]

	Program year of training								
	PGY1			PGY2			PGY3		
	Resident	NHANES	Difference/ Odds ratio	Resident	NHANES	Difference/ Odds ratio	Resident	NHANES	Difference/ Odds ratio
Weight status									
BMI*	24.2(0.27)[b]	27.9(0.43)	**-3.75 (-4.70,-2.78)**[c]	23.4(0.38)	27.4(0.61)	**-4.00 (-5.36,-2.65)**	25.1(0.50)	26.1(0.81)	-1.03** (-2.82,0.76
Overweight BMI ≥ 25	0.34 (0.28,0.41)[d]	0.65 (0.58,0.71)	**0.28 (0.19,0.41)**[e]	0.26 (0.19,0.35)	0.57 (0.47,0.66)	**0.27 (0.15,0.48)**	0.45 (0.33,0.58)	0.55 (0.43,0.67)	0.67 (0.33,1.34
Blood Pressure									
SBP	125.74(1.05)	116.21(0.89)	**9.53 (7.18,11.88)**	125.98(1.47)	112.47(1.25)	**13.51 (10.22,16.80)**	125.91(1.95)	114.62(1.68)	**11.19 (6.77,15.61**
DBP*	76.08(0.67)	69.43(0.84)	**6.65 (4.58,8.72)**	77.59(0.94)	65.84(1.19)	**11.75 (8.85,14.65)**	78.69(1.25)	68.31(1.59)	**10.38 (6.49,14.26**
Hypertension SBP≥140 or DSP≥ 90	0.21 (0.16,0.27)	0.08 (0.06,0.13)	**2.82 (1.58,5.06)**	0.22 (0.15,0.31)	0.02 (0.01,0.07)	**13.76 (3.09,61.20)**	0.17 (0.09,0.29)	0.09 (0.04,0.20)	2.08 (0.74,5.84

Abbreviations: PGY, Post-Graduate Year; YNHH, Yale New Haven Hospital; OHSU, Oregon Health & Sciences University; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); SBP, systolic blood pressure; DBP, diastolic blood pressure.

[a] Data come from the National Health and Nutrition Examination Survey (NHANES) 2005-2006, matched for age, gender, race, and years of education.

[b] Least Squares Mean (Standard Error). [c] Difference of Least Squares Mean (95% Confidence Interval of Difference of Least Squares Mean).

[d] Adjusted proportion from the model (95% Confidence Interval of the adjusted proportion). [e] Odds Ratio (95% Confidence Interval of Odds Ratio).

* P-value for interaction by program year < 0.05. Bold indicates statistical significance.

**The magnitude of the difference at the beginning of the 3rd year was less than those at either the 1st or 2nd year.

There were no significant differences in systolic BP between the cases (resident physicians) and the controls. However, there was a statistically significant difference in diastolic BP with an increased magnitude of difference over the three years (6.7 versus 10.4, P=0.01). This change was not reflected in increased rates of hypertension; there was no evidence to support a difference between the groups of cases versus controls in rates of hypertension across the years of training.

QUALITATIVE

In the course of enrolling and measuring the resident physicians, there were a series of observations and comments made by the resident physicians that were recorded by the enrolling staff. There were several consistent themes in these qualitative comments. First, while resident physicians were eager to participate, they often did not know their measurements, want to know their measurements, or believe their measurements. For example, one resident physician said, “You can weigh me for the study but don’t tell me the results.” Another subject requested, “You can weigh me, but please do it in kilograms because I can’t convert right away.”

Resident physicians frequently explained their reluctance to be measured because they felt that it was not representative. For example, one resident physician explained that she had just started exercising last week. Another explained that she had just gone out to dinner the night before.

Resident physicians were also frequently reluctant to believe their blood pressure measurement, even post call. Several resident physicians requested repeatedly to re-

measure their blood pressure in order to demonstrate that it was “normal.” One research assistant mentioned that she demonstrated the blood pressure cuff on herself to confirm its accuracy.

Lastly, several resident physicians were eager to suggest that they were making changes. One mentioned before enrollment that she was about to join a gym. Another subject returned to the recruiting location two weeks after being enrolled in order to be reweighed and demonstrate his weight loss. Several nursing students and even faculty members approached the team to determine whether they too were eligible to enroll.

It is clear from these qualitative reflections that while most resident physicians are eager and willing to participate in a study about their own health, many of them also had a sustained disbelief in the results, even after viewing repeated measurements.

DISCUSSION

Our results indicated that resident physicians are more than twice as likely to be overweight at the beginning of their third year than they are at the beginning of their first year. This conclusion is supported by both the primary cross-sectional analysis and the secondary longitudinal analysis. BP measurements suggest similar though not statistically significant trends in the cross-sectional analysis. Our results also indicated that while resident physicians at PGY1 were statistically less likely to be overweight than their matched controls, there were significant changes in the rate of weight gain by year of training. Furthermore, their diastolic BP was markedly higher than that of matched controls through-out all three post graduate years.

These findings are consistent with those of previous studies suggesting a national trend of weight gain. They seem to indicate that the rate of increase of BMI is higher among resident physicians. This supports a reasonable assumption that year of residency training would also be associated with increased likelihood of having an elevated BMI and increased BP.

We were unable to demonstrate an association between a change in eating habits or physical activity and a change in BMI; however, we were able to confirm descriptively that resident physicians who were categorized as overweight were also more likely to engage in some unhealthful eating behaviors such as frequently eating at sit-down restaurants, and drinking sugar-sweetened beverages. We were also able to demonstrate differences in outcomes between medical and surgical resident physicians. However, while it is true that these subsamples have different health measurements, there is

insufficient evidence to support the notion that those differences are associated with differences in the programs in particular, and not the demographics of the resident physicians enrolled.

Of note, the cross-sectional analysis and the longitudinal analysis yielded slightly different trends in achieving statistical significance. While both noted strong evidence for change from PGY1 to PGY3, the cross sectional analysis also demonstrated strong evidence for changes from PGY2 to PGY3, while the longitudinal analysis demonstrated strong evidence for changes from PGY1 to PGY2. We suspect that these differences in achieving statistical significance were due to the non-linear nature of the association and not due to any inherent differences among the populations.

To our knowledge, this is the first prospective study that monitors the BMI and BP of resident physicians. Our findings of this weight gain are consistent with those of previously studied groups at colleges and universities, and are additionally supported by the findings of our matched analysis using the NHANES database. The use of the control group strengthens our conclusions that not only do resident physicians gain weight, but they do so at a different rate from their national counterparts.

This study's enrollment of a substantial cohort of resident physicians over an extended length of time lends strength to its conclusions. Our results have biologic plausibility. During the course of their training, resident physicians are placed under professional and personal pressure to develop a high level of clinical skills. Examining the physical well-being of the resident physician is a novel and potentially important method of reviewing the goals and adverse consequences of clinical training. Mechanisms that could contribute to these trends include increased stress levels,

decreased quality and quantity of sleep, and limited time outside of the hospital to access resources such as work out facilities and supermarkets.

Our study has several limitations. It is possible that the resident physicians who declined to be re-enrolled have different patterns of weight change than those who were re-measured. However, we found no reason to suspect this change in our analysis of responder to non-responders. After emailing resident physicians for follow up, we had a variety of responses. There were some who refused, some who never replied, and some who agreed but could not schedule a meeting time. However, we failed to find any significant differences in the baseline characteristics in the longitudinal and cross-sectional samples among those who were enrolled longitudinally and those who were not.

Analysis of these two groups, as well as secondary analysis comparing the demographics of responders to the demographics of non-responders, produced different trends in achieving statistical significance. This suggests that there are some differences that were not detected between the groups. Additionally, the process of data collection introduces potential opportunities for biases. Our use of multiple research assistants enrolling resident physicians in a variety of settings at two centers may have introduced a collection bias.

Another limitation is that the NHANES database is an imperfect control group for this cohort given the limitations imposed by the creation of a 1:1 matched group. Both control and cohort group indicated a statistically significant difference in weight gain comparing each of the PGY groups. The NHANES database is representative of a reasonable control sample as it mirrors the national trend of steady weight gain. Given the national trend of increasing BMI, any NHANES cohort would naturally bias the

analysis against a difference between the trends of resident physicians and those of controls. We did not find this to be the case. Instead, we found that resident physicians' weight gain changed at a different rate than that of controls.

Our study demonstrated that resident physicians have a greater likelihood of being overweight at PGY3 than at PGY1. Overweight resident physicians are less able to demonstrate accurate self-assessment of their weight status than are normal-weight resident physicians. These findings have important clinical implications as well as important medical education implications. Resident physicians must be informed of the general trend and the potential effects both on their own health and on their interactions with patients.

Health maintenance programs and weight-gain prevention interventions may be implemented to address this trend. Such interventions include educational programs, specified time during the day for physical exercise, with in-hospital fitness centers as well as affordable and easily available healthy food options for the opportunity to improve health outcomes. Additional research is required to determine significant contributing factors, the precise description of the differences among years, and whether long-term follow-up supports these findings.

REFERENCES

1. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. JAMA 2006;295:1549-55.
2. Kuczmarski RJ, Flegal KM, Campbell SM, Johnson CL. Increasing prevalence of overweight among US adults. The National Health and Nutrition Examination Surveys, 1960 to 1991. JAMA 1994;272:205-11.
3. Ogden CL, Yanovski SZ, Carroll MD, Flegal KM. The epidemiology of obesity. Gastroenterology 2007;132:2087-102.
4. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. JAMA 1999;282:1523-9.
5. Olshansky SJ, Passaro DJ, Hershow RC, et al. A potential decline in life expectancy in the United States in the 21st century. N Engl J Med 2005;352:1138-45.
6. Flegal KM, Graubard BI, Williamson DF, Gail MH. Weight-associated deaths in the United States. J Womens Health (Larchmt) 2007;16:1368-70.
7. Adams KF, Schatzkin A, Harris TB, et al. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. N Engl J Med 2006;355:763-78.
8. Calle EE, Teras LR, Thun MJ. Adiposity and physical activity as predictors of mortality. N Engl J Med 2005;352:1381-4; author reply -4.
9. Calle EE, Teras LR, Thun MJ. Obesity and mortality. N Engl J Med 2005;353:2197-9.
10. Flegal KM, Graubard BI, Williamson DF, Gail MH. Cause-specific excess deaths associated with underweight, overweight, and obesity. JAMA 2007;298:2028-37.
11. John U, Hanke M, Grothues J, Thyrian JR. Validity of overweight and obesity in a nation based on self-report versus measurement device data. Eur J Clin Nutr 2006;60:372-7.
12. Willett K, Jiang R, Lenart E, Spiegelman D, Willett W. Comparison of bioelectrical impedance and BMI in predicting obesity-related medical conditions. Obesity (Silver Spring) 2006;14:480-90.
13. Brown CD, Higgins M, Donato KA, et al. Body mass index and the prevalence of hypertension and dyslipidemia. Obes Res 2000;8:605-19.
14. Burt VL, Whelton P, Roccella EJ, et al. Prevalence of hypertension in the US adult population. Results from the Third National Health and Nutrition Examination Survey, 1988-1991. Hypertension 1995;25:305-13.
15. O'Donnell CJ, Ridker PM, Glynn RJ, et al. Hypertension and borderline isolated systolic hypertension increase risks of cardiovascular disease and mortality in male physicians. Circulation 1997;95:1132-7.
16. Gault R, Yeater RA, Ullrich IH. West Virginia physicians: cardiovascular risk factors, lifestyles and prescribing habits. W V Med J 1994;90:364-6.
17. Paeratakul S, Lovejoy JC, Ryan DH, Bray GA. The relation of gender, race and socioeconomic status to obesity and obesity comorbidities in a sample of US adults. Int J Obes Relat Metab Disord 2002;26:1205-10.
18. Miech RA, Kumanyika SK, Stettler N, Link BG, Phelan JC, Chang VW. Trends in the association of poverty with overweight among US adolescents, 1971-2004. JAMA 2006;295:2385-93.

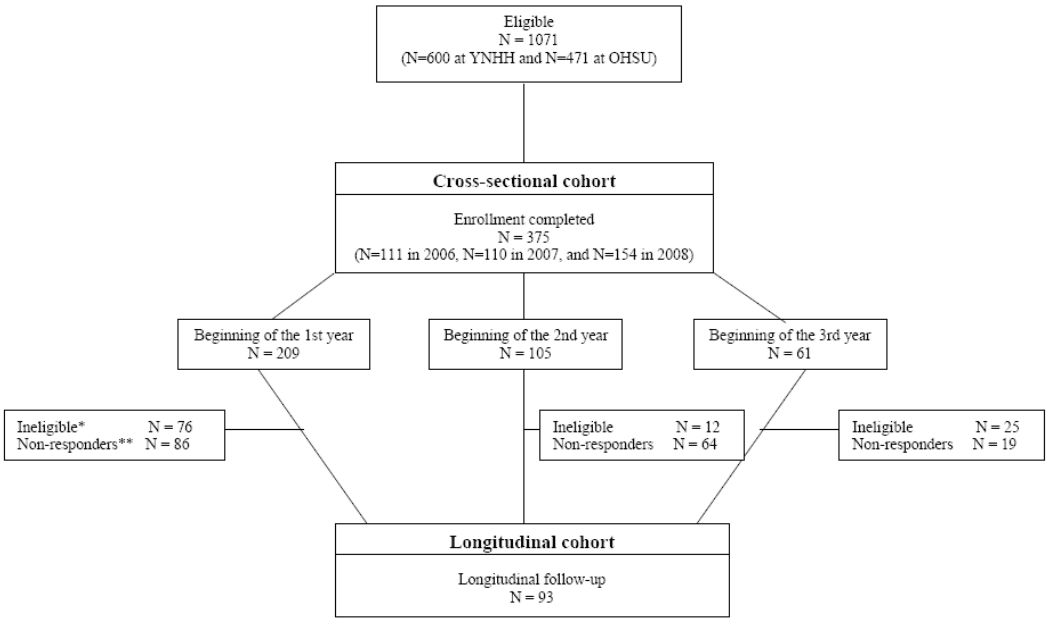
19. Park MJ, Paul Mulye T, Adams SH, Brindis CD, Irwin CE, Jr. The health status of young adults in the United States. J Adolesc Health 2006;39:305-17.
20. Salsberg E, Rockey PH, Rivers KL, Brotherton SE, Jackson GR. US residency training before and after the 1997 Balanced Budget Act. JAMA 2008;300:1174-80.
21. Landrigan CP, Barger LK, Cade BE, Ayas NT, Czeisler CA. Interns' compliance with accreditation council for graduate medical education work-hour limits. JAMA 2006;296:1063-70.
22. Kellogg KC, Breen E, Ferzoco SJ, Zinner MJ, Ashley SW. Resistance to change in surgical residency: an ethnographic study of work hours reform. J Am Coll Surg 2006;202:630-6.
23. Barger LK, Ayas NT, Cade BE, et al. Impact of extended-duration shifts on medical errors, adverse events, and attentional failures. PLoS Med 2006;3:e487.
24. Iglehart JK. Revisiting duty-hour limits--IOM recommendations for patient safety and resident education. N Engl J Med 2008;359:2633-5.
25. Lockley SW, Barger LK, Ayas NT, Rothschild JM, Czeisler CA, Landrigan CP. Effects of health care provider work hours and sleep deprivation on safety and performance. Jt Comm J Qual Patient Saf 2007;33:7-18.
26. Papp KK, Stoller EP, Sage P, et al. The effects of sleep loss and fatigue on resident-physicians: a multi-institutional, mixed-method study. Acad Med 2004;79:394-406.
27. Ramsay MA. Physician fatigue. Proc (Bayl Univ Med Cent) 2000;13:148-50.
28. Arnedt JT, Owens J, Crouch M, Stahl J, Carskadon MA. Neurobehavioral performance of residents after heavy night call vs after alcohol ingestion. JAMA 2005;294:1025-33.
29. Becker JL, Milad MP, Klock SC. Burnout, depression, and career satisfaction: cross-sectional study of obstetrics and gynecology residents. Am J Obstet Gynecol 2006;195:1444-9.
30. Daugherty SR, Baldwin DC, Jr., Rowley BD. Learning, satisfaction, and mistreatment during medical internship: a national survey of working conditions. JAMA 1998;279:1194-9.
31. Reddy R, Guntupalli K, Alapat P, Surani S, Casturi L, Subramanian S. Sleepiness in medical ICU residents. Chest 2009;135:81-5.
32. Surani S, Subramanian S, Aguillar R, Ahmed M, Varon J. Sleepiness in medical residents: impact of mandated reduction in work hours. Sleep Med 2007;8:90-3.
33. Bruce CT, Thomas PS, Yates DH. Burnout and psychiatric morbidity in new medical graduates. Med J Aust 2005;182:599; author reply
34. Schneider KM, Monga M, Kerrigan AJ. Stress in residency: reality or myth? Am J Obstet Gynecol 2002;186:907-9.
35. Ruser CB, Sanders L, Brescia GR, et al. Identification and management of overweight and obesity by internal medicine residents. J Gen Intern Med 2005;20:1139-41.
36. Frank E, Biola H, Burnett CA. Mortality rates and causes among U.S. physicians. Am J Prev Med 2000;19:155-9.
37. Mountain SA, Quon BS, Dodek P, Sharpe R, Ayas NT. The impact of housestaff fatigue on occupational and patient safety. Lung 2007;185:203-9.

38. Harris SS, Caspersen CJ, DeFriese GH, Estes EH, Jr. Physical activity counseling for healthy adults as a primary preventive intervention in the clinical setting. Report for the US Preventive Services Task Force. JAMA 1989;261:3588-98.
39. Galuska DA, Will JC, Serdula MK, Ford ES. Are health care professionals advising obese patients to lose weight? JAMA 1999;282:1576-8.
40. Wells KB, Lewis CE, Leake B, Ware JE, Jr. Do physicians preach what they practice? A study of physicians' health habits and counseling practices. JAMA 1984;252:2846-8.
41. Hash RB, Munna RK, Vogel RL, Bason JJ. Does physician weight affect perception of health advice? Prev Med 2003;36:41-4.
42. Frank E, Breyan J, Elon L. Physician disclosure of healthy personal behaviors improves credibility and ability to motivate. Arch Fam Med 2000;9:287-90.
43. Foster KY, Diehl NS, Shaw D, et al. Medical students' readiness to provide lifestyle counseling for overweight patients. Eat Behav 2002;3:1-13.
44. Frank E, Carrera JS, Elon L, Hertzberg VS. Predictors of US medical students' prevention counseling practices. Prev Med 2007;44:76-81.
45. Block JP, DeSalvo KB, Fisher WP. Are physicians equipped to address the obesity epidemic? Knowledge and attitudes of internal medicine residents. Prev Med 2003;36:669-75.
46. Banasiak M, Murr MM. Medical school curricula do not address obesity as a disease. Obes Surg 2001;11:677-9.
47. Frank E, Galuska DA, Elon LK, Wright EH. Personal and clinical exercise-related attitudes and behaviors of freshmen U.S. medical students. Res Q Exerc Sport 2004;75:112-21.
48. Park ER, Betancourt JR, Kim MK, Maina AW, Blumenthal D, Weissman JS. Mixed messages: residents' experiences learning cross-cultural care. Acad Med 2005;80:874-80.
49. Cornuz J, Ghali WA, Di Carlantonio D, Pecoud A, Paccaud F. Physicians' attitudes towards prevention: importance of intervention-specific barriers and physicians' health habits. Fam Pract 2000;17:535-40.
50. Campbell S, Delva D. Physician do not heal thyself. Survey of personal health practices among medical residents. Can Fam Physician 2003;49:1121-7.
51. Frank E, Bhat Schelbert K, Elon L. Exercise counseling and personal exercise habits of US women physicians. J Am Med Womens Assoc 2003;58:178-84.
52. Rimpela AH, Nurminen MM, Pulkkinen PO, Rimpela MK, Valkonen T. Mortality of doctors: do doctors benefit from their medical knowledge? Lancet 1987;1:84-6.
53. Gross CP, Mead LA, Ford DE, Klag MJ. Physician, heal Thyself? Regular source of care and use of preventive health services among physicians. Arch Intern Med 2000;160:3209-14.
54. Najem GR, Passannante MR, Foster JD. Health risk factors and health promoting behavior of medical, dental and nursing students. J Clin Epidemiol 1995;48:841-9.
55. Perry MY, Osborne WE. Health and wellness in residents who matriculate into physician training programs. Am J Obstet Gynecol 2003;189:679-83.

56. Spencer EH, Frank E, Elon LK, Hertzberg VS, Serdula MK, Galuska DA. Predictors of nutrition counseling behaviors and attitudes in US medical students. Am J Clin Nutr 2006;84:655-62.
57. Mihalopoulos NL, Auinger P, Klein JD. The Freshman 15: is it real? J Am Coll Health 2008;56:531-3.
58. Haberman S, Luffey D. Weighing in college students' diet and exercise behaviors. J Am Coll Health 1998;46:189-91.
59. Bertsias G, Mammas I, Linardakis M, Kafatos A. Overweight and obesity in relation to cardiovascular disease risk factors among medical students in Crete, Greece. BMC Public Health 2003;3:3.
60. Racette SB, Deusinger SS, Strube MJ, Highstein GR, Deusinger RH. Weight changes, exercise, and dietary patterns during freshman and sophomore years of college. J Am Coll Health 2005;53:245-51.
61. Matvienko O, Lewis DS, Schafer E. A college nutrition science course as an intervention to prevent weight gain in female college freshmen. J Nutr Educ 2001;33:95-101.
62. Gans KM, Risica PM, Wylie-Rosett J, et al. Development and evaluation of the nutrition component of the Rapid Eating and Activity Assessment for Patients (REAP): a new tool for primary care providers. J Nutr Educ Behav 2006;38:286-92.
63. Segal-Isaacson CJ, Wylie-Rosett J, Gans KM. Validation of a short dietary assessment questionnaire: the Rapid Eating and Activity Assessment for Participants short version (REAP-S). Diabetes Educ 2004;30:774, 6, 8 passim.
64. Marshall AL, Smith BJ, Bauman AE, Kaur S. Reliability and validity of a brief physical activity assessment for use by family doctors. Br J Sports Med 2005;39:294-7; discussion -7.
65. Brown H, Prescott R. Applied Mixed Models in Medicine. Chichester, UK: John Wiley and Sons; 1999.
66. Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. Biometrika 1986;73:13-22.
67. MacKinnon DP, Warsi G, Dwyer JJ. A simulation study of mediated effect measures. Multivariate Behavioral Research 1995;30:41-62.
68. Center for Disease Control and Prevention Health and Nutrition Examination Survey. Available at: http://www.cdc.gove/nhcs/about/major/nhanes/datalink.htm. Accessed September 26, 2008. (Accessed at
69. Bergstralh EJ, Kosanke JL. Computerized matching of cases to controls. Technical Report Series No. 56. Rochester, MN: Section of Biostatistics, Mayo Clinic, 1995.
70. Rosenbaum PR. Optimal matching for observational studies. J Am Stat Assoc 1989;84:1024-32.

FIGURES

Figure 1. Enrollment of Resident Physicians



* Ineligible indicates pregnant, graduated, or PGY1 in 2008.
** Non-responders indicate not approached prior to 2008, not enrolled due to scheduling conflict, no reply, or refusal.

Figure 2. Data Collection Form

Changing Health Status of Medical and Surgical Residents

Demographic Information

Participant #: _____ Gender: M F

Program (title): _____ Height (cm): _____

Year of Study: 1 2 3 Other Weight (kg): _____

Physical Activity (Circle the best choice)

1) How many times a week do you usually do 20 minutes of vigorous physical activity that makes you sweat or puff and pant? (for example, jogging, heavy lifting, digging, aerobics, or fast bicycling)

A. 3 times/week
B. 1–2 times/week
C. none

2) How many times a week, do you usually do 30 minutes of moderate physical activity or walking that increases your heart rate or makes you breath harder than normal? (for example, mowing the lawn, carrying light loads, bicycling at a regular pace, or playing doubles tennis)

A. 5 times/week
B. 3–4 times/week
C. 1–2 times/week
D. none

Blood Pressure (measured in the LEFT arm)

Systolic		
Diastolic		

Self Description (circle one): Underweight Normal Weight Overweight Very Overweight

Age (years): _____ Ethnicity: CA AfA LA AsA O

Figure 3. Eating Habits Survey[1]

REAP-S (Rapid Eating Assessment for PARTICIPANTS -- Shortened version)
CJ Segal-Isaacson EdD RD, Kim Gans PhD, Judy Wylie-Rosett EdD RD, ©2006

In an average week, how often do you:	Usually/ Often	Sometimes	Rarely/ Never	Does not apply to me
1. Skip breakfast?	O	O	O	
2. Eat 4 or more meals from sit-down or take out restaurants?	O	O	O	
3. Eat less than 3 servings of whole grain products or high fiber starches a day? **Serving** = 1 slice of 100% whole grain bread; 1 cup whole grain cereal like Shredded Wheat, Wheaties, Grape Nuts, high fiber cereals, oatmeal, 3-4 whole grain crackers, ½ cup brown rice or whole wheat pasta, boiled or baked potatoes, yuca, yams or plantain.	O	O	O	
4. Eat less than 2-3 servings of fruit a day? **Serving** = ½ cup or 1 med. fruit or 4 oz. 100% fruit juice.	O	O	O	
5. Eat less than 3-4 servings of vegetables/potatoes a day? **Serving** = ½ cup vegetables or potatoes, or 1 cup leafy raw vegetables.	O	O	O	
6. Eat or drink less than 2-3 servings of milk, yogurt or cheese a day? **Serving** = 1 cup milk or yogurt; 1½ - 2 ounces cheese.	O	O	O	
7. Eat more than 6 ounces (see sizes below) of meat, chicken, turkey or fish per day? ***Note**: 3 ounces of meat or chicken is the size of a deck of cards or ONE of the following: 1 regular hamburger, 1 chicken breast or leg (thigh and drumstick), or 1 pork chop.*	O	O	O	Rarely eat meat, chicken, turkey or fish O
8. Use regular processed meats (like bologna, salami, corned beef, hotdogs, sausage or bacon) instead of low fat processed meats (like roast beef, turkey, lean ham; low-fat cold cuts/hotdogs)?	O	O	O	Rarely eat processed meats O
9. Eat fried foods such as fried chicken, fried fish, French fries, fried plantains, tostones or fried yuca?	O	O	O	
10. Eat regular potato chips, nacho chips, corn chips, crackers, regular popcorn, nuts instead of pretzels, low-fat chips or low-fat crackers, air-popped popcorn?	O	O	O	Rarely eat these snack foods O
11. Add butter, margarine or oil to bread, potatoes, rice or vegetables at the table?	O	O	O	
12. Eat sweets like cake, cookies, pastries, donuts, muffins, chocolate and candies more than 2 times per day.	O	O	O	
13. Drink 16 ounces or more of non-diet soda, fruit drink/punch or Kool-Aid a day? ***Note:** 1 can of soda = 12 ounces*	O	O	O	
	YES			**NO**
14. You or a member of your family usually shops and cooks rather than eating sit-down or take-out restaurant food?	O			O
15. Usually feel well enough to shop or cook.	O			O
16. How willing are you to make changes in your eating habits in order to be healthier?	**1 Very willing**	**2**	**3**	**4**	**5 Not at all willing**

[1] Written permission for use granted by Kim Gans, PhD

TABLES

Table 1. Participants' Characteristics at Each PGY

	All N=375	PGY1 N=209	PGY2 N=105	PGY3 N=61
Demographics				
Age (y)	28.6 ±[a] 3.0	28.6 ± 3.0	28.9 ± 2.9	29.4 ± 2.7
Gender				
Female	204 (54.4)[b]	102 (48.8)	62 (59.1)	40 (65.6)
Race				
Caucasian	259 (69.1)	144 (68.9)	73 (69.5)	42 (68.9)
Other	116 (30.9)	65 (31.1)	32 (30.5)	19 (31.2)
Site				
YNHH	258 (68.8)	153 (73.2)	62 (59.1)	43 (70.5)
OHSU	117 (31.2)	56 (26.8)	43 (41.0)	18 (29.5)
Clinical Outcomes				
BMI	24.1 ± 3.9	24.2 ± 3.9	23.4 ± 3.6	25.1 ± 4.2
≥ 25	125 (33.5)	71 (34.0)	27 (26.0)	27 (45.0)
Blood Pressure				
SBP	125.8 ± 15.0	125.7 ± 15.7	126.0 ± 15.1	125.8 ± 12.3
DBP	76.9 ± 9.7	76.1 ± 9.6	77.6 ± 10.4	78.7 ± 8.2
Hypertension				
SBP ≥ 140 or DSP ≥ 90	76 (20.5)	43 (20.9)	23 (21.9)	10 (17.0)
Behaviors				
Physical Activity				
Yes	206 (56.0)	117 (57.1)	50 (48.5)	39 (65.0)
Eating Habits				
Eat 4+ times/wk at restaurants	209 (56.3)	113 (54.6)	63 (60.1)	33 (55.0)
Eat high fat snack food	186 (49.6)	93 (44.5)	61 (58.1)	32 (52.5)
Eat high sugar snack food	229 (61.1)	130 (62.2)	62 (59.1)	37 (60.7)
Consume sweetened drinks	83 (22.1)	47 (22.5)	22 (21.0)	14 (23.0)
Self-Description				
Normal	266 (74.9)	151 (76.3)	75 (76.5)	40 (67.8)
Overweight	89 (25.1)	47 (23.7)	23 (23.5)	19 (32.2)

Abbreviations: PGY, Post-Graduate Year; YNHH, Yale New Haven Hospital; OHSU, Oregon Health & Sciences University; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); SBP, systolic blood pressure; DBP, diastolic blood pressure.

[a] Mean ± Standard Deviation.

[b] N (%).

Table 2. Participants' Characteristics by Program (N=375)

Characteristics		Medical (N=239)	Surgical (N=136)
Weight (kg)		**69.7 ± 14.3**	**73.9 ± 16.5**
Height (m)		1.70 ± 0.09	1.73 ± 0.11
BMI		23.82 ± 3.86	24.63 ± 3.86
Overweight	**BMI ≥ 25**	**69 (29.1)**	**56 (41.2)**
Systolic Blood Pressure (mmHg)		124.4 ± 13.5	128.3 ± 17.0
Diastolic Blood Pressure (mmHg)		76.9 ± 9.3	77.0 ± 10.2
Hypertension	**Yes (SBP ≥ 140 or DSP ≥ 90)**	**41 (17.4)**	**35 (26.1)**
Race/Ethnicity	**Caucasian American**	**175 (73.2)**	**84 (61.8)**
	Non-Caucasian American	**64 (26.8)**	**52 (38.2)**
Age (years)		**28.4 ± 2.8**	**29.04 ± 3.2**
	Age ≤ 28	**148 (61.9)**	**75 (55.2)**
	Age > 28	**91 (38.1)**	**61 (44.9)**
Site	**Yale**	**175 (73.2)**	**83 (61.0)**
	OHSU	**64 (26.8)**	**53 (39.0)**
Gender	Female	135 (56.5)	69 (50.7)

[α] Plus-minus values are Mean ± SD.
[β] Data on categorical variable is presented as number of subjects (%).
[*] Bolded P < .05, when compared resident physicians in Medical and Surgical groups.

Table 3. Regression of BMI and Blood Pressure in Cross-sectional and Longitudinal cohorts[¥]

		Program year of training			Comparisons between program years		
		PGY1	PGY2	PGY3	PGY3 vs. PGY1	PGY3 vs. PGY2	PGY2 vs PGY1
Cross-sectional cohort							
Weight status							
BMI		24.1(0.29)[a]	23.8(0.37)	25.6(0.48)	**1.47(0.45,2.48)**[b]	**1.83(0.70,2.95)**	-0.36(-1.20,0.48)
Overweight	BMI ≥ 25	0.30(0.22,0.39)[c]	0.25 (0.17,0.35)	0.49 (0.34,0.64)	**2.26(1.19,4.28)**[d]	**2.87(1.39,5.92)**	0.79(0.45,1.38)
Blood Pressure							
SBP		126.1(1.10)	127.3(1.40)	128.2(1.84)	2.04(-1.87,5.95)	0.82(-3.48,5.12)	1.22(-1.98,4.42)
DBP		76.8(0.79)	78.5(1.00)	79.7(1.32)	**2.88(0.08,5.68)**	1.15(-1.92,4.23)	1.73(-0.56,4.02)
Hypertension	SBP≥140orDSP≥90	0.22 (0.15,0.30)	0.25 (0.16,0.37)	0.21 (0.12,0.35)	0.92(0.41,2.06)	0.78(0.32,1.86)	1.19(0.64,2.19)
Longitudinal cohort							
Weight status							
BMI		23.4(0.59)	23.7(0.56)	23.9(0.58)	0.42(-0.23,1.07)	0.18(-0.31,0.68)	0.24(-0.23,0.71)
Overweight	BMI ≥ 25	0.12 (0.06,0.24)	0.19(0.10,0.36)	0.24 (0.12,0.43)	**2.32(1.17,4.62)**	1.28(0.70,2.35)	**1.82(1.07,3.11)**
Blood Pressure							
SBP		126.3(2.20)	124.4(1.97)	123.9(2.12)	-2.46(-6.11,1.18)	-0.56(-3.46,2.35)	-1.91(-4.81,1.00)
DBP		78.1(1.88)	79.2(1.65)	78.7(1.80)	0.62(-2.70,3.95)	-0.47(-3.18,2.23)	1.10(-1.65,3.84)
Hypertension	SBP≥140 or DSP≥90	0.11 (0.04,0.19)	0.10(0.05,0.21)	0.19 (0.09,0.35)	1.95(0.80,4.77)	2.05(0.82,5.09)	0.96(0.34,2.67)

Abbreviations: PGY, Post-Graduate Year; YNHH, Yale New Haven Hospital; OHSU, Oregon Health & Sciences University; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); SBP, systolic blood pressure; DBP, diastolic blood pressure.
Bolded indicates statistical significance.
[a] Least Squares Mean (Standard Error). [b] Difference of Least Squares Mean (95% Confidence Interval of Difference of Least Squares Mean).
[c] Adjusted proportion from the model (95% Confidence Interval of the adjusted proportion). [d] Odds Ratio (95% Confidence Interval of Odds Ratio).
[¥] Adjusted by age at the first year of program year, gender, race, and site.

Table 4. Participants' REAP, Physical activity, and Self-description by Overweight/Non-overweight (N=375)

Characteristics		Overweight (BMI ≥ 25) (N=125)	Non-overweight (BMI < 25) (N=248)	Overall (N=373[#])
REAP2	**Usually/Often**	**36 (29.2)**	**50 (20.3)**	**86 (23.3)**
	Sometimes	**47 (38.1)**	**75 (30.5)**	**122 (33.1)**
	Rarely/Never	**40 (32.5)**	**121 (49.2)**	**161 (43.6)**
REAP10	Usually/Often	14 (11.2)	22 (8.9)	36 (9.7)
	Sometimes	45 (36.0)	105 (42.3)	150 (40.2)
	Rarely/Never	66 (52.8)	121 (48.8)	187 (50.1)
REAP12	Usually/Often	25 (20.0)	38 (15.3)	63 (16.9)
	Sometimes	53 (42.4)	112 (45.2)	165 (44.2)
	Rarely/Never	47 (37.6)	98 (39.5)	145 (38.9)
REAP13	**Usually/Often**	**17 (13.6)**	**22 (8.9)**	**39 (10.5)**
	Sometimes	**19 (15.2)**	**24 (9.7)**	**43 (11.5)**
	Rarely/Never	**89 (71.20)**	**202 (81.5)**	**291 (78.0)**
Physical activity	Yes	74 (61.2)	131 (53.47)	205 (56.0)
	No	47 (38.8)	114 (46.53)	161 (44.0)
Self-Description	**Normal**	**52 (43.3)**	**212 (91.0)**	**264 (74.8)**
	Overweight	**68 (56.7)**	**21 (9.0)**	**89 (25.2)**

[#] Two subjects do not have weight or height measurements.

[β] Data on categorical variable is presented as number of subjects (column %).

[*] Bolded P-value < 0.05 from a trend test for the REAP questionnaire and a chi-square test for the Physical activity and self-description

[§] REAP Q**2**: Eat 4 or more meals from sit-down or take out restaurants? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never

REAP Q**10**: Eat regular potato chips, nacho chips, corn chips, crackers, regular popcorn, nuts? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never

REAP Q**12**: Eat sweets more than 2 times per day? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never

REAP Q**13**: Drink 16 ounces or more of non-diet soda, fruit drink/punch or Kool-Aid day? 1-Usually/Often, 2-Sometimes, 3-Rarely/Never