TWENTY–YEAR TRENDS IN THE PREVALENCE AND PREDICTORS OF HEALTHCARE PROVIDER ADVICE TO LOSE WEIGHT: U.S. NHANES, 1999–2018

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A THESIS SUBMITTED TO
THE FACULTY OF GRADUATE STUDIES
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF THE MASTER OF SCIENCE

GRADUATE PROGRAM IN KINESIOLOGY AND HEALTH SCIENCE

YORK UNIVERSITY
TORONTO, ONTARIO

JULY 2025

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Abstract

Healthcare providers (HCP) play a critical role in screening for obesity and supports for obesity management. We examined 1999–2018 trends in the prevalence and predictors of U.S. adults being told to lose weight using ten nationally representative NHANES cycles (n=16,424). Survey-weighted descriptive statistics and multivariable logistic regression identified sociodemographic, anthropometric (BMI, WC), clinical (MetS, EOSS), and behavioral predictors stratified by age, sex, and ethnicity. Overall, 34.4% reported ever receiving weight-loss advice; the prevalence rose from 11.1% to 19.2% among overweight and from 20.9% to 33.4% among obese individuals. Adjusted models showed older age, female sex, higher BMI (OR overweight = 6.15; obese = 41.86), elevated WC (OR = 8.37), and EOSS stages 2 (OR = 3.90) and 3 (OR = 5.07) were strong independent predictors, while socioeconomic and behavioral factors were modest. HCP weight-loss advice increased over two decades but remains predominantly driven by simple anthropometric measures; integrating comprehensive clinical risk tools like EOSS may improve equitable obesity care.

Acknowledgements

This thesis would not have been possible without the National Health and Nutrition Examination Survey database provided by the Centers for Disease Control and Prevention, whose two-decade long data collection made this research possible.

I want to express my deepest gratitude to the university and my examining committee for the opportunity to pursue further education in academia. Finally, I would like to extend my most sincere appreciation to my supervisor, Dr. Chris Arden, for his kindness, guidance, and continuous support throughout my studies. Thank you for the incredible experiences and knowledge you've imparted with me. I also want to express gratitude to Dr. Jennifer Kuk and my lab mates for their invaluable assistance and support throughout this study.

Table of Contents

Abstract ii
Acknowledgements iii
Table of Contents iv
List of Tables vi
List of Figures vii
Background 1
Literature Review 3
Anthropometry 3
Variation in Health Risk by BMI and WC 3
Clinical Practice Guidelines 7
Weight Bias and Stigma in Healthcare 8
Patterns of HCP Weight Loss Advice 9
Objectives 9
Methods 11
Study Sample 11
Survey Methods 12
Mobile Exam Centre 12
Metabolic Syndrome (MetS) 13
Edmonton Obesity Staging System (EOSS) 14
Study Sample Selection 16
Statistical Analysis 18
Results 19
Prevalence in being told overweight 19
Temporal trends Prevalence 22
Predictors of weight loss-advice 25
Discussion 31
Sociodemographic and Behavioral Patterns 31
Exploring predictors of being told they are overweight by a HCP 34
Adjusted comparison of obesity-risk tools and HCP bias 37
Study Limitations 38
Conclusion 40

Next Steps 41
References 43
Appendices 50
Appendix A 50
Appendix B 57
Appendix C 63

List of Tables

Table 1. Description of the Edmonton Obesity Staging System (EOSS) and clinical management guidelines[23] 6

Table 2. Edmonton Obesity Staging System (EOSS) study operational definition[41] based on conceptual EOSS definition[23] 15

Table 3. Socio-demographic and clinical characteristics of U.S. adults from NHANES 1999 – 2018 ever told by a health provider they were overweight. 21

Table 4. Unadjusted Odds Ratio with 95% confidence limits of socio-demographic and medical characteristics of U.S. adults from NHANES 1999-2018 ever told by a health provider they were overweight. 26

Table 5. Comparison of anthropometric measurement Odds Ratio (OR) with 95% confidence limits (CI) adjusted for socio-demographic and medical characteristics of U.S. adults from NHANES 1999-2018 ever told by a health provider they were overweight. 30

Supplementary Table 6 A–D) 20-year temporal trends of socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018. 53

List of Figures

Figure 1. Flowchart of analytical study sample selection of U.S. adults from NHANES 1999 – 2018 being told they were overweight by a healthcare provider. 17

Figure 2. Temporal trends of changes in participant prevalence of overweight and obesity of "ever being told by a HCP you were overweight" of U.S. adults from NHANES in 1999–2018.24

Figure 3. Forrest plot of unadjusted odd ratio predicting odds of being told one was overweight by HCP (95% Confidence Intervals). 28

Figure 4. Forest plot of independent anthropometric measurement odds ratio comparison with 95% confidence limits adjusted for socio-demographic and medical characteristics of U.S. adults from NHANES 1999-2018 ever told by a health provider they were overweight 30

Supplementary Figure 5 A–C) Socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018. 50

Supplementary Figure 6 A–H. 20-year temporal trends of socio-demographic characteristic prevalence of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018. 57

Supplementary Figure 7. 20-year temporal trends of clinical characteristic prevalence of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018. 59

Supplementary Figure 8. 20-year temporal trends of socio-demographic characteristics predicting odd ratio of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018. 60

Supplementary Figure 9. 20-year temporal trends of clinical characteristics predicting odd ratio of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018. 62

Background

Obesity is a progressive chronic disease characterized by an abnormal or excessive fat accumulation impairing health metabolically and functionally.[1] In 2016 the World Health Organization (WHO) reported that over 1.9 billion adults were overweight, 30% of whom were obese.[1,2] In Canada alone, the prevalence of obesity in adults has increased three-fold since 1985, and one-in-three adults in Canada living with obesity may require medical support to manage their disease.[3] In the management of obesity, primary care providers (PCP) or other healthcare providers (HCP) are central to identifying obesity-related health risk.

Although HCPs are armed with a wealth of medical knowledge on the comorbidities of, and intervention strategies for, obesity, bariatric medicine is a sub-specialty that has garnered relatively little attention until recently.[4] Indeed, obesity has recently be recognized as a chronic disease that is both progressive in nature, and subject to relapse.[5] The inherent complexity of obesity means that the same "risk factors" are not experienced equally by all persons with obesity (PwO), and relatively few of the traditionally assessed predictors of obesity would be considered "modifiable".[3]

Despite their good intentions, PCPs in particular, may be unprepared to deal with the complexity of obesity, and like the general public, may be inclined to overemphasize the role of personal choice, and the contribution of diet and exercise to one's weight.[6] The resulting weight bias (negative attitudes, beliefs), stigma (stereotyping behaviors), or discrimination (action) has been implicated in a lower quality of care for PwO.[7] How a healthcare provider approaches the topic of weight in the clinical exam, may well have a large influence in the longer-term health outcomes[6] and referral for relevant and timely care.[8]

It is therefore important to understand how clinician advisor advice to lose weight may have changed over time in relation to trends in overweight and obesity, and its designation by the American and Canadian Medical Associations as a "disease".[3]

Literature Review

Anthropometry

Introduced almost two centuries earlier by Quetelet, it was not until the mid 1980s that Body Mass Index (BMI) gained prominence as the most universal measure for classifying and screening an individual's weight in relation to their health.[9,10] With the 1998 release of the *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults* from the NHLBI Obesity Education Initiative Expert Panel, which established revised (lower) BMI thresholds for overweight and obesity, the U.S. Centres for Disease Control (CDC) further established the use of the metric in the clinical setting and as a standard for population health.[10,11] In 2003, Health Canada followed suit with the release of the *Canadian Guidelines for Body Weight Classification in Adults*, adopting the same BMI classicisation framework as the CDC[12] BMI (kg/m^2) has been used to classify individuals as underweight 18.5, "normal weight" (18.5-24.9), "overweight" (25-29.9), and "obese" (30+), which is further subclassified into class 1 (30-24.9), class 2 (35-39.9), and class 3 (≥40) obesity.[13] In conjunction with BMI, this most recent guideline acknowledges the importance of fat mass location, and advocates for the measurement of waist circumference (WC) to track increase abdominal adiposity and obesity-related health risks (defined as >88 cm in women, and >102 cm in men). Evidenced for the inclusion of WC thresholds as a proxy for abdominal (central) body fat is demonstrated by the higher health risk associated with type 2 diabetes, hypertension, dyslipidemia, and metabolic syndrome (MetS, which combines all 3 of the conditions).[11,14]

Variation in Health Risk by BMI and WC

The value of BMI and WC in the clinic setting is that they are easy-to-use tools for HCPs to approximate adiposity, and subsequent health risk, for their patients. Despite the conveniences

of theses anthropometric tools, they must be used with caution. For example, BMI can not differentiate fat and lean tissue, and may provide more meaningful insight into population (than individual) health, which has led to debate over the generalizability of their use, particularly in Asian ethnic groups and older adults. It has been more than two decades since a committee of WHO experts first reviewed the scientific evidence for the association between BMI, percentage of body fat, and health risks in Asian vs European populations.[15] Examples from two prominent cohort studies can be used to illustrate these ethnic differences. In the first, the Nurses Health Study tracked patterns of weight gain and diabetes development in US women, and after 20 years, Asian American participants had two times the risk of developing type 2 diabetes than White Americans at the same BMI.[16,17] In the same study, Hispanic, Black, and White Americans who gained weight over time had less of an increase in health risk than their Asian counterparts. In the second, Asians were shown to have a consistently higher risk of hypertension and cardiovascular disease than their white European counterparts, when matched for BMI.[18] The resulting consensus was that for population-level tracking and determination of individual health risk, lower BMI thresholds for overweight (23.5 rather than 25kg/m2) and obesity (27.5 rather than 30 kg/m2) should be applied.[15]

Variation in BMI-health relationships have also been shown in relation to age and sex, with the underlying hypothesis being that body composition and genetics may be playing a role which should be accounted for each individual when making assessments. With advancing age, the association of BMI and cardiovascular and all-cause mortality tends to weaken, whereas the excess body weight tends to increase the risk of death from any cause and from cardiovascular disease in adults between 30 to 74 years of age. Individuals who are older and overweight have been shown to display an “obesity paradox” wherein they are are protected against the risk of falls, and effects to chronic diseases when compared to leaner individuals.[19]

More recently, focus has turned to addressing the limitations of BMI and WC classifications through development of other pre-clinical risk factor tools, such as Metabolic Syndrome (MetS) and the Edmonton Obesity Staging System, for the tracking of obesity-related health risks. MetS is a "constellation of conditions" that increase a person's risk of diabetes and cardiovascular disease[20] that is defined by the presence of three or more of the following: high blood pressure (≥130/85 mmHg /regulated by medication), high blood glucose levels (≥5.6 mmol/L /regulated by medication), high triglycerides (≥1.7 mmol/L /regulated by medication), low HDL-Cholesterol (<1.0 mmol/L in men or <1.3 mmol/L in women), and large waist circumference (≥88 cm in women and ≥102 cm in men),[21] In general, individuals with MetS are at twice the risk of developing cardiovascular disease (CVD) over the next 5 to 10 years in comparison to individuals without the syndrome.[22] The incorporation of MetS will provide an advantage to estimate the risks of CVD or all-cause mortality by their primary care provider in individuals living with obesity.

From the early 1980s to mid 2000s, obesity 'classification' and assessments were done by using BMI and WC tools that largely focused on all-cause mortality (and leading causes of death, like cardiovascular disease). In 2009, the Edmonton Obesity Staging System (EOSS) emerged as a new clinical assessment tool, that using a holistic approach to the limitations of anthropometric classifications, can take into consideration the broader array of *physical, functional, and mental health* comorbidities associated with obesity.[23] The EOSS staging tool is based on simple clinical assessments that include medical history, clinical and functional assessments which include BMI defined obesity classes, and routine diagnostic investigations. Each of the five stages provides a baseline measurement for the presence and severity of risk factors, comorbidities, and functional limitations, as well as a guide for patient management as described below.[23]

Table 1. Description of the Edmonton Obesity Staging System (EOSS) and clinical management guidelines[23]

Stage	Description of physical, functional and psychological assessment	Management
0	No signs of obesity related risk factors, physical symptoms, psychological symptoms, or functional limitations	Identify factors contributing to increased body weight. Counseling could be prescribed to prevent further weight gain through lifestyle changes
1	Characterized as the presence of obesity-related subclinical and borderline risk factors, mild physical symptoms (e.g. mild dyspnea/shortness of breath, pain and aches, fatigue etc.)	Investigate for any non-weight related risk factors. Providers are recommended to prescribe more intense lifestyle interventions such as diet and lifestyle. Patients will be monitored of risk factors and health status in the future
2	Presence of established obesity-related chronic diseases with moderate limitations in activities of daily living and well being	Close monitoring and management of comorbidities. Providers may consider initiating behavioural, pharmacological, and surgical options
3	Established end-organ damage (e.g. myocardial infarction, heart failure, kidney failure etc.), significant functional limitations and/or impairment of well being	More intensive obesity management of comorbidities by including all behavioral, pharmacological, and surgical treatment options
4	Severe or end-stage disabilities or disease related to obesity, severe psychopathology, severe functional limitations, and/or impairment of wellbeing	Due to severities of disease, aggressive obesity management may be prescribed as feasible. However due to the severity of disability, palliative measures would be advised for pain management, occupational and psychosocial therapies

Clinical Practice Guidelines

Given the importance of HCPs to the prevention, identification, and management of obesity, Obesity Canada convened a series of Expert Panel working groups that led to the publication of the *Canadian Adult Obesity Clinical Practice Guidelines* in 2020. These guidelines provide recommendations for PwO and how HCPs can facilitate a patient's weight loss journey. They also build on the 5As framework for Obesity Management in Adults developed in 2011 by Obesity Canada, to provide educational resources for HCPs on clinical and psychological interventions and methods for clinicians to approach sensitive issues involving weight.[23,24]

In contrast, U.S. guidance has a longer history of defining obesity thresholds and treatment approaches. The 1998 *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults* issued by the NHLBI Expert Panel (U.S.) formally established lower BMI cut-points for overweight and obesity, and provided evidence-based recommendations for the clinical evaluation and management of obesity.[11,12] These guidelines set the stage for the widespread adoption of BMI as the primary tool for obesity classification in the United States and influenced clinical practice and public health surveillance for decades.

Canada adopted combined BMI and WC cut-points slightly later. Health Canada's 2003 *Canadian Guidelines for Body Weight Classification in Adults* introduced BMI thresholds for overweight and obesity that aligned with international standards, providing a consistent framework for surveillance and clinical screening.[12] Since then, Canadian guidance has continued to evolve to place less emphasis on BMI alone and greater focus on the lived experience of people with obesity, patient–provider communication, and long-term management strategies.

In the newest 2020 guidelines in Canada there is less emphasis on BMI alone, and greater focus on the lived experience of people with obesity, patient–provider communication, and long-

term management strategies.[3] It is well known that PwO frequently experience weight bias and stigma in their day-to-day lives, but until recently, the impacts of weight bias and discrimination on obesity management has been poorly understood.[25] Obesity Canada's 5As was designed as a step-by-step framework for the busy non-specialist (PCPs) who manages obesity as part of their daily practice. The 5As include: i) 'Ask' for permission to discuss weight and explore readiness; ii) 'Assess' obesity related risks and root causes; iii) 'Advise' on health risks and treatment options; iv) 'Agree' on health outcomes and goals, and; v) 'Assist' in accessing appropriate resources and providers.[24] With weight being a naturally sensitive issue, this framework helps providers to approach weight-related health concerns in a non-judgemental manner. For healthcare providers (HCPs or PCPs), the 5As help to raise awareness that obesity must be managed as a chronic condition, and provide a framework to help guide an initial, respectful conversation about weight, before building towards long-term management goals and patient-specific outcomes.[26]

Weight Bias and Stigma in Healthcare

Existing shortcomings in healthcare providers training for obesity management are further complicated by the wide-spread belief that "diet" and "exercise" should be the primary mode of intervention for successful treatment.[27,28] Regardless of the intervention, weight loss, followed by weight regain (i.e. weight fluctuation) is common,[29] and the relative importance of modifiable lifestyle factors (e.g. dietary intake and physical activity) are often overvalued for their importance in weight balance, and as a result, the general population, and HCP alike, are prone to blaming patients and individuals with obesity as lacking inherent will power or for being lazy.[7] This is despite wide-spread scientific understanding that the contributors to obesity are multifactorial - and that there is a web of inter-related social, consumer, political, medical, behavioral, and genetic factors - that may contribute to a person's susceptibility to gain weight, or conversely, maintain

weight loss over time.[30,31] Indeed, over 66% of individuals with obesity report experiencing weight stigma or discrimination within the healthcare setting over the past decade.[32] Importantly, the presence of weight stigma by HCPs can reduce the quality of care for PwO, despite their best intentions.[7]

Patterns of HCP Weight Loss Advice

While the health effects of excess weight are generally understood, HCPs may not have confidence in their training,[33] or there may not be sufficient time[34] to engage in meaningful patient-providers conversations about weight. In 2019, only 10.9% of individuals with who were overweight or obesity in the U.S. had *'been told to by a HCP to lose weight'* and sought help from a health professional for weight loss.[35] Despite this, receiving weight loss advice from an HCP is associated with better health outcomes;[37] however, the appropriateness of such advice, and reasons behind HCP advice for PwO to lose weight are not known. Moreover, it is not clear whether objective assessments of health are the most important factors in such advice, or whether implicit bias (and an overemphasis on a person's appearance, diet, or physical activity level), may be overvalued even in the healthcare setting. Given that well over 80% of lost weight is regained within five years and only about 20% of individuals maintain at least a 10% reduction in body weight at one year,[38,39] ensuring that weight loss advice is holistically discussed with patients at highest risk.

Objectives

The purpose of this study was to identify twenty-year trends in the prevalence and predictors of individuals living with overweight or obesity being told by a healthcare provider that they should lose weight. By expanding on de Heer et al.'s analysis limited to NHANES 2011–

2012[35] and building on Greaney et al.'s cross-sectional examination of provider counselling behaviors for weight management in NHANES 2011–2018,[36] this analysis has the potential to provide additional insight into the patient-providers relationship over the course of 20 years.

Objective 1: To identify what prevalence of PwO in the U.S. has been told to lose weight by a health care providers.

Aim 1: To examine whether patterns of being told to lose weight by a HCP vary across time (1999-2020) in the U.S, and to determine the extent to which patterns of advice to lose weight are consistent with increases in the prevalence of overweight and obesity in the U.S.

Aim 2: To explore whether being told to lose weight by a HCP has changed over time in proportion to demographic shifts in sex, age, and ethnicity in the U.S.

Objective 2: To identify predictors of being told to lose weight among individuals living with overweight or obesity.

Aim 1: To quantify the relationship between being told to lose weight and various pre-clinical tools for obesity (e.g. anthropometrics (BMI, waist circumference (WC)), and other, more comprehensive health assessment tools (e.g. MetS, obesity phenotypes, and the physical component of EOSS staging) over time.

Aim 2: To examine the sociodemographic, behavioral, and medical factors that predict HCP advice to lose weight, and to determine the extent to which these patterns may vary across age, sex, and ethnic subgroups of the population.

Methods

Study Sample

The study will utilize merged data from the National Health and Nutrition Examination Survey (NHANES). The program is a nationally representative cross-sectional study designed to assess the health and nutritional status of adults and children in the United States of America. The survey is uniquely comprised of interviews and physical examinations, where findings from the data can provide information on the prevalence of major diseases and risk factors. Data was collected by the Centre for Disease Control (CDC), and all survey participants expressed written consent to take part in the study. Data for the current analysis is available through a public-use microdata file on the NCHS website in an anonymized form that is free from identifying information (https://www.cdc.gov/nchs/nhanes/index.htm). Ethics approval was obtained from the National Center for Health Statistics Research Ethics Review Board (ERB) for NHANES 1999-2004 (Protocol #98-12), NHANES 2005-2010 (Protocol #2005-06), NHANES 2011-2016 (Protocol #2011-17) on which data for this analysis was used. Additional details are available at: https://www.cdc.gov/nchs/nhanes/irba98.htm. Informed, written consent was obtained from all participants. This study is an analyses of NHANES publicly available anonymized data, and thus, does not require further ethical review from the York University institutional review board.

NHANES continuous cycles are released biannually, and the merged data will cover the time periods from 1999 – 2020. Because of the less consistent relationship between BMI and health risk in older adults, the main study analysis includes all adults 20y+ but was stratified by age to explore the possibility that HCP may not be aware of this relationship (and may therefore prescribe weight loss more frequently to older individuals with greater pre-exiting health risk).

Survey Methods

Demographic information including age, sex, ethnicity, education, smoking status, alcohol consumption, poverty-to-income ratio, physical activity, and medical history. These variables will be used to adjust the primary outcome for sample demographics and baseline comorbidities. Age was grouped into three categories: 18–44, 45–64, and ≥65 years. In NHANES documentation and some descriptive tables, the older age category may be reported as 65–74 years; however, for the purposes of this analysis, the category was treated as 65+ to ensure consistency across cycles. The ≥65 cut-point was selected given the historical bell-shaped distribution of obesity across the life course, where older age is generally associated with lower prevalence and somewhat protective effects relative to middle-aged adults. In addition, age was also examined in 10-year increments during stratified analyses to provide greater resolution across the adult lifespan.

The key measure that will be used to assess the prevalence of providers telling their patients they will need to lose weight is MCQ080. The survey question is described as: Participants were asked whether in the past 12 months*, "Has a doctor or other health professional ever told {you/SP} that {you were/s/he/SP was} overweight?"*.[40] Results are coded as "yes", "no", "refused", "don't know" or "missing". Because this question was only introduced into the NHANES survey in 1999, the current analysis will include data from 1999 to 2020, representing the most recent up-to-date pre-COVD survey relevant for the current analysis.

Mobile Exam Centre

All body measurements were obtained by trained health technicians at the mobile examination centre (MEC). Standing height was measured to the nearest tenth of a centimeter, and body weight in kilograms. BMI was subsequently calculated as a person's weight in kilograms

divided by height in meters squared (kg/m^2). The following WHO BMI cut-offs were assigned, as follows:

1. Underweight <18.5 kg/m^2
2. Normal weight ≥18.5 - <25 kg/m^2
3. Overweight ≥25 - <30 kg/m^2
4. Obese ≥30 kg/m^2
5. Class I obesity ≥30 - <35 kg/m^2
6. Class II obesity ≥35 - <40 kg/m^2
7. Class III obesity ≥40 kg/m^2

Higher waist circumference was classified using established sex-specific cut-points: ≥88 cm for women and ≥102 cm for men. These thresholds reflect levels associated with an increased risk of cardiometabolic complications.[11] Physical activity was defined according to whether participants met the threshold for moderate-to-vigorous physical activity (MVPA). MVPA was calculated as the total number of self-reported minutes of physical activity per week. Participants reporting <150 minutes per week were categorized as inactive, while those reporting ≥150 minutes per week were categorized as active, consistent with current public health guidelines.[41]

Metabolic Syndrome (MetS)

Consistent with Metabolic Syndrome Canada and the National Cholesterol Education Program (NCEP) Adult Treatment PanelIII (ATPIII) criteria for defining metabolic syndrome, MetS was operationalized by the presence of three or more of the following metabolic factors:[21]

1. High blood pressure (≥ 130/85 mm Hg, or receiving medication)

2. High blood glucose levels (≥ 5.6 mmol/L, or receiving medication)
3. High triglycerides (≥ 1.7 mmol/L, or receiving medication)
4. Low HDL-Cholesterol (< 1.0 mmol/L in men or < 1.3 mmol/L in women)
5. Large waist circumference (≥ 102 cm in men, 88 cm in women; ranges vary according to ethnicity)

Edmonton Obesity Staging System (EOSS)

The EOSS stages were set based on the cut-offs defined in Table 2. To establish EOSS scores for each study participant, a modified set of stage criteria were applied, as adapted from Canning et al. 2015.[42] As per previous NHANES analyses,[43] the current study was limited to EOSS Stage 0 to 3, due to insufficient data on palliative or end-stage conditions included in Stage 4. See **Appendix C** for SAS syntax used to code EOSS staging.

Table 2. Edmonton Obesity Staging System (EOSS) study operational definition[42] based on conceptual EOSS definition[23]

EOSS stage	Conceptual EOSS definition[23]	Study definition[42]
0	No signs of obesity related risk factors, physical symptoms, psychological symptoms, or functional limitations	No EOSS factors reported
1	Characterized as the presence of obesity-related subclinical and borderline risk factors, mild physical symptoms (e.g. mild dyspnea/shortness of breath, pain and aches, fatigue etc.)	Any of the following: 1. Glucose ≥ 5.6 mmol/L 2. Cholesterol ≥ 5.2 mmol/L 3. Triglycerides ≥ 1.7 mmol/L 4. HDL ≤ 1.6 mmol/L 5. LDL ≥ 3.3 mmol/L 6. SBP ≥ 130 mmHg 7. DBP ≥ 85 mmHg
2	Presence of established obesity-related chronic diseases with moderate limitations in activities of daily living and well being	Any of the following: 1. Glucose ≥ 6.9 mmol/L 2. Diagnosed type 2 diabetes or type 2 diabetes medication 3. Cholesterol ≥ 6.2 mmol/L 4. Diagnosed hypercholesterolaemia 5. Triglycerides ≥ 2.2 mmol/L 6. HDL ≤ 1.0 mmol/L 7. LDL ≥ 4.1 mmol/L 8. Diagnosed hyperlipidemia or hyperlipidemia medication 9. SBP ≥ 140 mmHg 10. DBP ≥ 90 mmHg 11. Diagnosed hypertension or hypertension medication 12. Sleep apnea 13. Gout 14. Arthritis 15. Anxiety 16. Atherosclerosis 17. Fatty liver 18. Congestive heart failure medication 19. Anticoagulants 20. Depression
3	Established end-organ damage (e.g. myocardial infarction, heart failure, kidney failure etc.), significant functional limitations and/or impairment of well being	Any of the following: 1. Angina 2. Heart attack 3. Heart failure 4. Thrombosis 5. Coronary artery disease 6. Coronary obstructive pulmonary disease 7. Dyspnea 8. Exercise dyspnea 9. Coronary artery bypass surgery 10. Stroke
4	Severe or end-stage disabilities or disease related to obesity, severe psychopathology, severe functional limitations, and/or impairment of wellbeing	No data available to evaluate this stage

Study Sample Selection

The analytic sample was drawn from 10 continuous NHANES cycles (1999–2018), comprising an initial total of 101,316 participants. A detailed flowchart outlining the sequential exclusion criteria applied is presented in **Figure 1**. Participants were excluded if they had missing responses to the weight counseling question (n = 28,019), were under 18 years of age (n = 14,141), or were missing data on key demographics (education: n = 4,235; poverty-to-income ratio: n = 5,249). Further exclusions were made for missing anthropometric or health-related variables, including BMI <18.5 kg/m² (n = 3,786), waist circumference (cm) (n = 1,954), physical activity (n = 294), and metabolic syndrome components (n = 7,761). Finally, participants missing data on smoking status (n = 19,453) were also excluded.

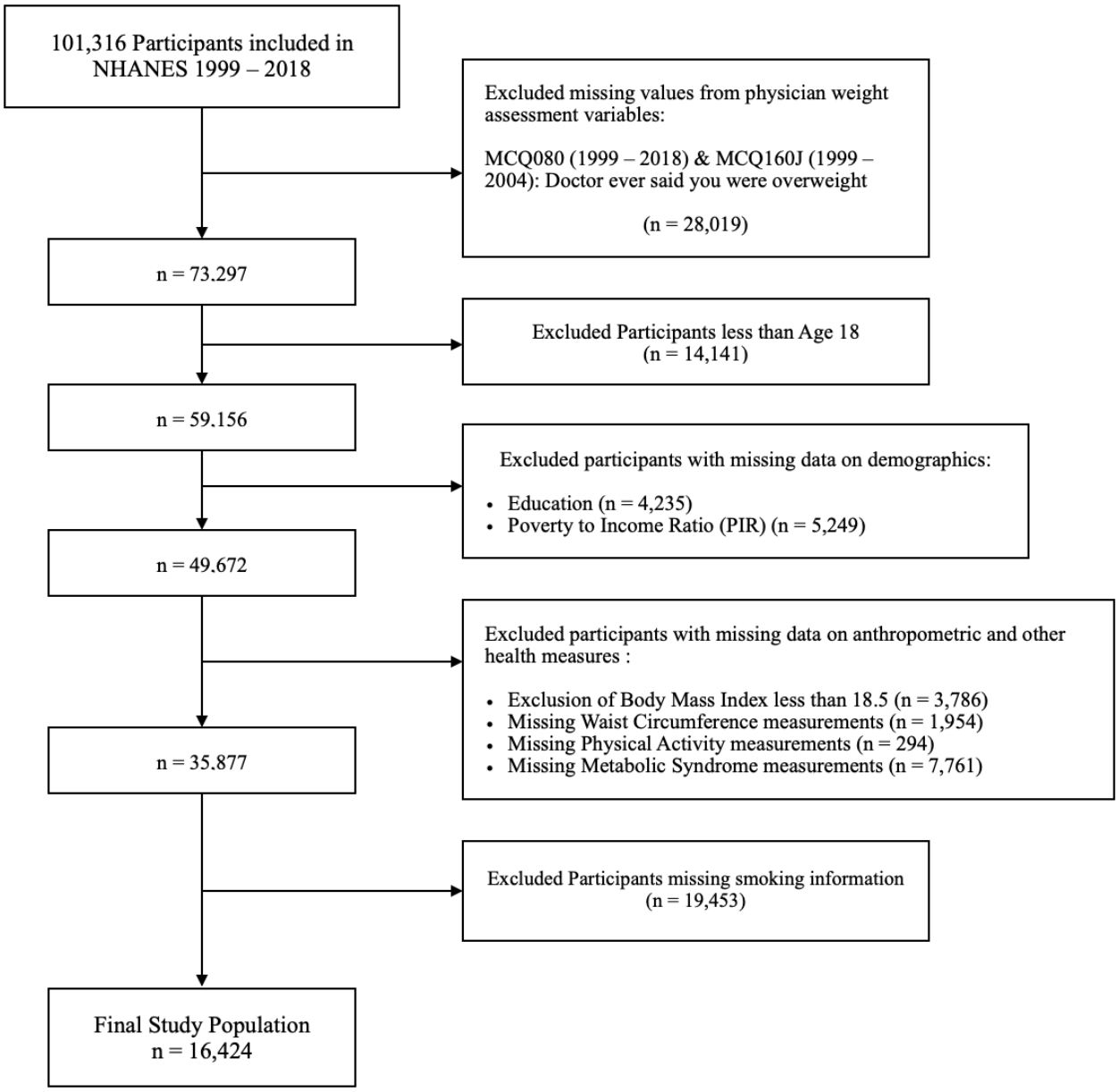

Figure 1. Flowchart of analytical study sample selection of U.S. adults from NHANES 1999 – 2018 being told they were overweight by a healthcare providers.

After applying all exclusions, the final analytic sample consisted of 16,424 participants aged 18 years or older. For primary analyses, adults aged **20 to 64 years** were retained to reflect clinical weight management guidance for working-age populations. A secondary sensitivity analysis was conducted among older adults aged **65 years and above** to assess whether clinical weight counseling differed among those with potentially greater baseline health risks

Statistical Analysis

Objective 1: Sociodemographic (age at screening, sex, ethnicity, education status, household income, etc.), medical (MetS, physical EOSS score, BMI, WC, and self-rated health, etc.), and behavioral (alcohol intake, smoking status, physical activity, fruit and vegetable consumption, etc.) characteristics were compared between those who have (vs have not) been told they were overweight with chi-square and independent sample t-tests for categorical and continuous data, respectively. Temporal trends (1999-2020) in the prevalence (±SE) of being told by a HCP they were overweight was then compared by chi-square analysis and plotted in relation to the prevalence of overweight and obesity by BMI and WC. Further data visualization was undertaken to explore subgroup variation, in analyses stratified by age (20-44y; 45-64y, and 65y+), sex (M, F), and ethnicity (Non-Hispanic White, Non-Hispanic Black, White, Other and Multiple ethnic groups).

Objective 2: To explore predictors of weight loss advice, a series of multivariable logistic (binary) regression models were used to: i) quantify the relationship between HCP weight loss advice (dependent variable: "HCP ever told {you/SP} that {you were/s/he/SP was} overweight" vs not told) and various sociodemographic, medical, and behavioral factors in a stepwise manner, and; ii) examine whether these patterns varied across time in relation to increasing trends in obesity.

Model fit was determined on the basis of pseudo-r^2 approach and through examination of -2LL statistics. Interactions between sex, obesity status, ethnicity, and survey year were explored.

All analyses were performed using SAS version 9.4, with statistical significance set at alpha = 0.05. Surveys were weighted using SAS survey *domain* procedures to ensure representativeness of the sample to the U.S. population.

Results

Prevalence in being told overweight

Table 3 presents a summary of the unadjusted socio-demographic and clinical profiles of 16,424 U.S. adults from the National Health and Nutrition Examination Survey (NHANES) conducted between 1999 and 2018. Notably, 5,646 (34.4%) of survey participants reported receiving advice from a healthcare providers about being overweight.

Among this group, those ever told they were overweight were significantly older (higher prevalence in the 45–64 years and ≥ 65 years groups; $p < .0001$) and slightly more likely to be female (17.6% vs. 17.3% in men; $p < .0001$), while race/ethnicity distributions did not differ by advice status ($p = 0.1365$). This advice was also more commonly directed towards White individuals (26.5%), and those with lower educational attainment (≤ high school diploma) and lower poverty-to-income ratios (PIR) (≤ 1.3) were both associated with greater likelihood of having been told they were overweight ($p < .0001$ and $p = .0007$, respectively). Individuals who reported being current smokers were *less* likely (12.9% vs. 21.9%; $p < .0001$), whereas participants engaging in moderate-to-vigorous physical activity were *more* likely to have been told they were overweight by a HCP (19.1% vs. not active 15.8%; $p < .0001$).

When considering clinical factors, individuals with MetS (21.2% vs 15.83; $p < 0.0001$), elevated WC (20.3% vs 23.7%; $p < 0.0001$), a BMI ≥ 30 (24.9% vs 9.9%; $p < .0001$), and those with a Stage 2 EOSS score were most likely to report being told they were overweight (22.0% vs 32.43%; $p < 0.0001$

Table 3. Socio-demographic and clinical characteristics of U.S. adults from NHANES 1999 – 2018 ever told by a health provider they were overweight.

	Ever told you were overweight					
	No		Yes			
Variables	n	%	n	%	% total	p-value
Age Groups (years)						<.0001
18 - 44	4512	31.18	1707	12.13	43.31	
45 - 64	3576	22.83	2380	15.58	38.41	
65 +	2690	11.09	1559	7.19	18.29	
Age Groups Stratified (years)						<.0001
18 -29	1797	12.5	474	3.37	15.87	
30 - 39	1856	12.67	727	5.09	17.77	
40 - 49	1775	12.64	1008	7.39	20.03	
50 - 59	1628	11.7	1118	8.08	19.78	
60 - 69	1791	8.19	1343	6.89	15.08	
70 - 79	1210	5	749	3.28	8.28	
80 +	721	2.4	227	0.8	3.2	
Sex						<.0001
Female	3940	26.18	2751	17.57	43.75	
Ethnicity						0.1365
Hispanic	2352	7.32	1240	3.53	10.86	
White	5671	48.45	3039	26.48	74.93	
Black	2014	5.83	1036	2.94	8.77	
Other	741	3.5	331	1.95	5.45	
Education						<.0001
Up to grade 11 or 12 - no diploma	3278	13.66	1437	5.92	19.58	
High school diploma or equivalent	2887	18.66	1408	9.12	27.78	
Some college or above	4613	32.78	2801	19.86	52.63	
Poverty to Income Ratio (PIR)						0.0007
≤ 1.3	3689	15.57	1776	7.55	23.12	
> 1.3 – ≤ 1.85	1509	7.53	758	3.63	11.17	
> 1.85	5580	42	3112	23.72	65.72	
Currently Smokers						<.0001
Yes	5341	32.95	2116	12.95	45.9	
Physically Active (MVPA)						<.0001
Yes	6055	39.38	2959	19.14	58.52	
Metabolic Syndrome						<.0001
Yes	2967	15.83	3512	21.18	37.01	
Higher Waist Circumference						<.0001
Lower Waist (F< 88; M <102 cm)	6686	41.40	726	4.53	45.93	
Higher Waist (F ≥ 88, M ≥102 cm)	4092	23.70	4920	30.37	54.07	
Body Mass Index Class (kg/m^2)						<.0001
18.5 - 24.9	4717	29.97	232	1.55	31.52	
25 - 29.9	4289	25.14	1353	8.48	33.62	
30 - 34.9	1388	8.06	1970	12.19	20.26	
35 - 39.9	281	1.42	1196	7.34	8.76	
40+	103	0.51	895	5.34	5.85	
Obesity						<.0001
Normal (18.5 - 24.9)	4717	29.97	232	1.55	31.52	
Overweight (25 - 29.9)	4289	25.14	1353	8.48	33.62	
Obese (30 +)	1772	9.99	4061	24.87	34.86	
Overweight						<.0001
Yes	6061	35.13	5414	33.35	68.48	
Total EOSS Score						<.0001
0	554	4.25	61	0.47	4.72	
1	2355	16.14	419	2.91	19.05	
2	5478	32.43	3381	22.02	54.45	
3	2391	12.28	1785	9.51	21.79	

Temporal trends Prevalence

Table 6 in Appendix A presents the temporal changes in prevalence of being told by a HCP they were overweight. Over the ten NHANES cycles from 1999–2000 to 2017–2018, the proportion of U.S. adults ever told by a HCP that they were overweight increased across all age groups (18–44 years: 11.1% to 16.1%; 45 – 64 years: 14.1% to 17.4%; ≥ 65 years: 5.0% to 9.4%; all $p < .01$). When further stratified by year, the prevalence of being told by an HCP they were overweight rose more markedly in the 50 – 59 y age group (6.9% in 1999–2000 to a high of 10.6% in 2015–2016, $p <.001$), and 60–69 y age groups (6.1% in 1999–2000 to a high of 10.82% in 2015–2016, $p <.001$).

These age-related patterns were observed in both men and women, with overall increases in the prevalence of advise to lose weight increasing slightly more in men (14.5% to 23.7%) than women (15.7% to 19.2%) over the 10 cycles (overall cycles $p < 0.04$), whereas the ethnic composition of those told they were overweight remained largely unchanged. On the other hand, socioeconomic disparities widened over time, with a non-significant trend towards an increase in the prevalence of having been told by an HCP they were overweight among those with a high school diploma (8.1% to 13.0%), compared with 14.8% to 24.9% in participants with some college or higher however ($p=0.06$). Individuals with a PIR greater than 1.85 showed the greatest increase in the prevalence of being told by a HCP they were overweight, with a greater than 30% relative increase observed between 1999-2000 (19.8%) and 2015–2016 (32.0%, $p=0. 06$). Finally, when considering lifestyle factors, current smokers remained less likely than non-smokers to report having been told overweight (11.8% to 14.1% vs. 18.3% to 28.8%; $p < .002$), while physically active individuals saw a larger increase in reporting being told by a HCP they were overweight (14.9% to 26.8%) than inactive peers (15.2% to 16.2%; $p >.05$).

When examining patterns of HCP advice in relation to markers of "weight" there appears to be a heightened attention to BMI and WC as proxies for poor "health", and therefore a trend towards a higher prevalence of HCP advice about their weight in more recent years. To this end, the proportion of adults in the overweight BMI category who reported ever being told they were overweight rose from 8.1% in 1999–2000 to a peak of 11.1% in 2015–2016, and among adults with obesity ($\geq$ 30 kg/m^2), the increase was even more pronounced (20.9% in 1999–2000 to 33.4% in 2017–2018, $p < .0001$). Figure 2 visualizes the temporal trends of general weight categories and the prevalence of being told by an HCP they were overweight.

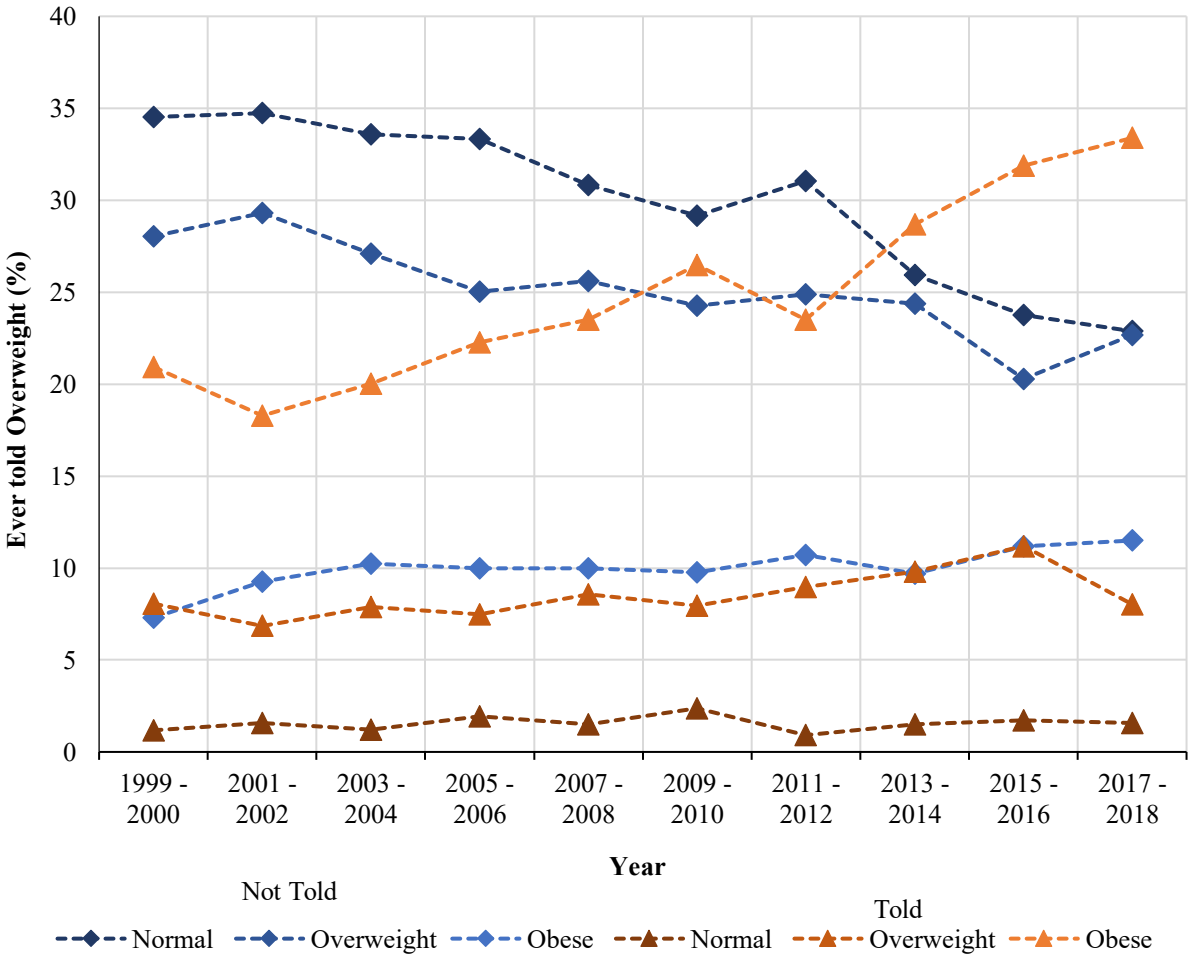

Figure 2. Temporal trends of changes in participant prevalence of overweight and obesity of "ever being told by a HCP you were overweight" of U.S. adults from NHANES in 1999–2018.

For clinical risk markers the patterns were even more pronounced. In those with MetS there was a notable upward trend from 18.1% being told they were overweight in 1999–2000 to 29.6% in 2017–2018 ($p < .0001$), whereas those with a high WC experienced an increase from 25.1% to 38.2%. In parallel, participants classified as EOSS stage 2 (indicating moderate obesity-related complications) saw their prevalence climb from 22.8% to 27.3%, while EOSS stage 3 (severe complications) rose from 4.5% to 12.0% ($p < .0001$ respectively).

Predictors of weight loss-advice

In unadjusted logistic regression analyses, both demographic characteristics and cardiometabolic risk were strongly associated with the likelihood of having been informed by a health professional of being overweight (Table 4). Compared with adults aged 18–44 y (OR=1.00, reference), those aged 45–64 y (OR=1.75, 95% CI: 1.59 – 1.93) and 65+y (OR=1.67, 95% CI: 1.48 – 1.88) had a much higher likelihood of receiving weight loss advice. When age was modeled into finer categories, odds increased progressively across from 40–49 y (OR=2.17; 95% CI: 1.82 – 2.59) to and 60–69 y (OR=3.13, 95% CI: 2.60 – 3.76) age groups before declining slightly (OR=2.43, 95% CI: 2.04 – 2.90) among those 70–79 y and markedly in the 80y+ age group (OR=1.23, 95% CI: 1.01 – 1.51). As expected, women were significantly more likely than men to report being told they were overweight (OR 1.51; 95% CI: 1.39 – 1.64), and among ethnic groups, Hispanic participants had slightly lower odds than non-Hispanic Whites (OR 0.88; 95% CI: 0.79 – 0.99), whereas Black and “Other” race categories did not differ significantly.

Table 4. Unadjusted Odds Ratio with 95% confidence limits of socio-demographic and medical characteristics of U.S. adults from NHANES 1999-2018 ever told by a health provider they were overweight.

Variables		Odds Ratio Estimates	95% Confidence Limits
Age (years)	18 – 44	1.00	-
	45 – 64	1.75	1.59, 1.93
	65 +	1.67	1.48, 1.88
Age (years) Stratified	18 – 29	1.00	-
	30 – 39	1.49	1.26, 1.76
	40 – 49	2.17	1.82, 2.59
	50 – 59	2.56	2.15, 3.06
	60 – 69	3.13	2.60, 3.76
	70 – 79	2.43	2.04, 2.90
	80 +	1.23	1.01, 1.51
Sex	Male	1.00	-
	Female	1.51	1.39, 1.64
Ethnicity	Hispanic	0.88	0.79, 0.99
	White	1.00	-
	Black	0.92	0.83, 1.02
	Other	1.02	0.84, 1.25
Education	Up to grade 11 or 12 – no diploma	1.00	–
	High school diploma or equivalent	1.13	1.00, 1.27
	Some college or above	1.40	1.26, 1.56
Poverty to Income Ratio (PIR)	≤ 1.3	1.00	–
	> 1.3 – ≤ 1.85	0.99	0.87, 1.14
	> 1.85	1.16	1.06, 1.27
Currently Smokers	No	1.00	–
	Yes	0.58	0.53, 0.62
Physically Active (MVPA)	No	1.00	–
	Yes	0.79	0.73, 0.87
Metabolic Syndrome	No	1.00	–
	Yes	4.80	4.39, 5.25
High Waist Circumference	Lower Waist (F< 88; M <102 cm)	1.00	–
	Higher Waist (F ≥ 88, M ≥102 cm)	11.71	10.33, 13.26
Body Mass Index (kg/m^2)	18.5 - 24.9	1.00	–
	25 - 29.9	6.53	5.32, 8.00
	30 - 34.9	29.27	23.78, 36.03
	35 - 39.9	100.16	76.94, 130.38
	40+	202.49	146.17, 280.50
Obesity	Normal	1.00	–
	Overweight	6.53	5.32, 8.00
	Obese	48.18	39.33, 59.02
Overweight	No	1.00	–
	Yes	18.37	15.13, 22.31
Total EOSS Score	0	1.00	–
	1	1.64	1.16, 2.32
	2	6.17	4.40, 8.65
	3	7.04	5.04, 9.85

Compared to the clinical and anthropometric markers, socioeconomic factors were only modestly related to HCP weight advice. Compared to those without a high-school diploma, individuals with higher educational attainment had slightly elevated odds of being told they were overweight (high school: OR=1.13; 95% CI: 1.00 – 1.27; some college or above OR=1.40; 95% CI: 1.26 – 1.56).The only significant relationship between PIR ratio and HCP advice was only observed in the most disadvantaged group (PIR >1.85 vs. ≤1.3 (reference), OR=1.16; 95% CI: 1.06 – 1.27).

As with the unadjusted prevalences, several behavioral and clinical risk markers were also related to HCP advice. This includes current smokers (OR 0.58; 95% CI: 0.53 – 0.62) and physically active individuals (OR 0.79; 95% CI: 0.73 – 0.87) who were 42% and 21% *less* likely than nonsmokers and *in*active individuals, respectively, to have been told they were overweight.

As expected, all anthropometric and clinical markers of "weight" were associated with HCP weight advice, including: a 4.80 times greater likelihood (95% CI: 4.39 – 5.25) amongst those with MetS; an 11.71 times greater odds (95% CI: 10.33 – 13.26) amongst those with elevated WC, and; a strong positive linear association between increasing BMI category (overweight: OR=6.53, 95% CI: 5.32 – 8.00; obesity class I: OR=29.27, 95% CI: 23.78 – 36.03); class II: OR=100.16, 95% CI: 76.94 – 130.38, and; class III: OR=202.49, 95% CI: 146.17 – 280.50). Finally, increasing severity of EOSS scores, particularly Stage 3 versus Stage 0 EOSS (OR = 1.00, reference group) was associated with a seven-fold higher likelihood of receiving HCP advice regarding their weights (OR 7.04, 95% CI: 5.04 – 9.85).

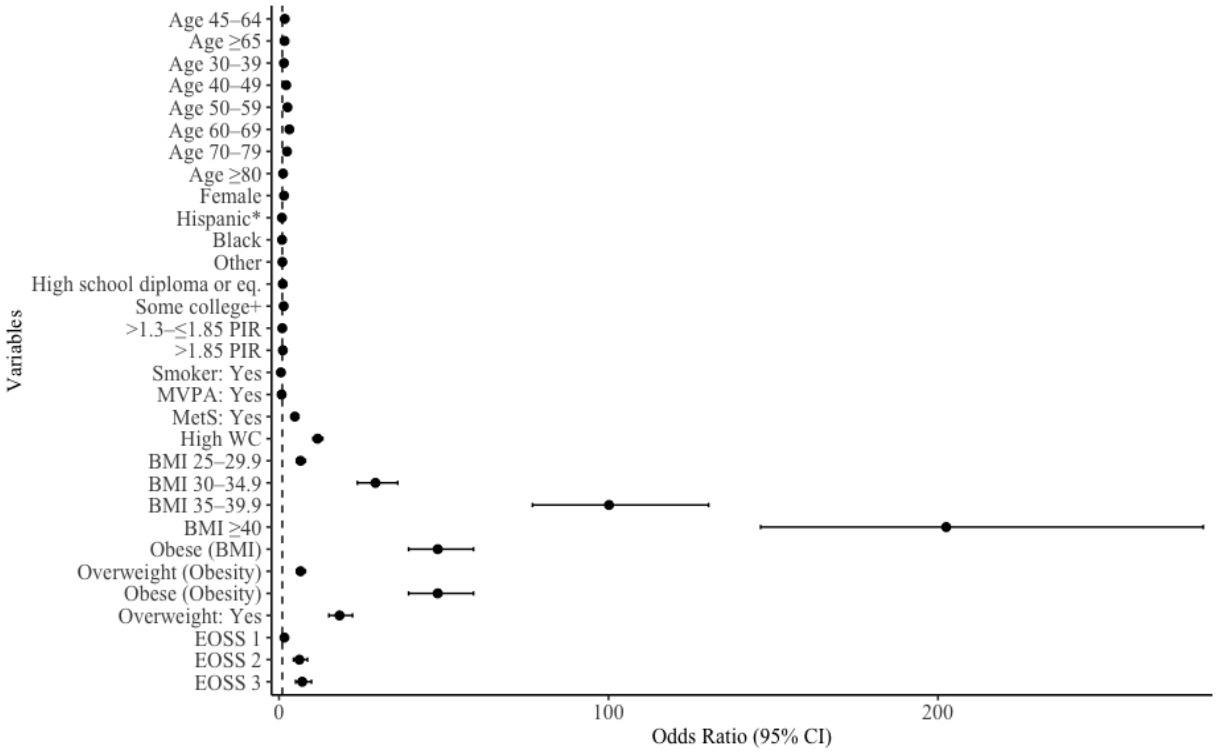

Figure 3. Forrest plot of unadjusted odd ratio predicting odds of being told one was overweight by HCP (95% Confidence Intervals).

After adjustment for demographic, socioeconomic, behavioral, and cardiometabolic covariates, all anthropometric and clinical markers of obesity risk remained significant independent predictors of HCP advice. This includes high WC (OR=8.37, 95% CI: 7.29 – 9.61) Stages 1, 2, and 3 EOSS scores (OR=1.91, 95% CI: 1.35 – 2.70; Stage 2: OR=3.90, 95% CI: 2.78 – 5.48, and; Stage 3: OR=5.07, 95% CI 3.62 – 7.09), as well as BMI (overweight: OR=6.15, 95% CI: 5.00 – 7.56; obesity: OR= 41.86, 95% CI: 34.03 – 51.48) (Table 5, Figure 4).

Table 5. Comparison of anthropometric measurement Odds Ratio (OR) with 95% confidence limits (CI) adjusted for socio-demographic and medical characteristics of U.S. adults from NHANES 1999-2018 ever told by a health provider they were overweight.

Anthropometric Measurements	HRWC		Total EOSS		Obesity (BMI)	
	OR	95% CI	OR	95% CI	OR	95% CI
Lower WC	1.00	–				
Higher WC	8.37	7.29, 9.61				
EOSS 0			1.00	–		
EOSS 1			1.91	1.35, 2.70		
EOSS 2			3.90	2.78, 5.48		
EOSS 3			5.07	3.62, 7.09		
Normal					1.00	–
Overweight					6.15	5.00, 7.56
Obese					41.86	34.03, 51.48

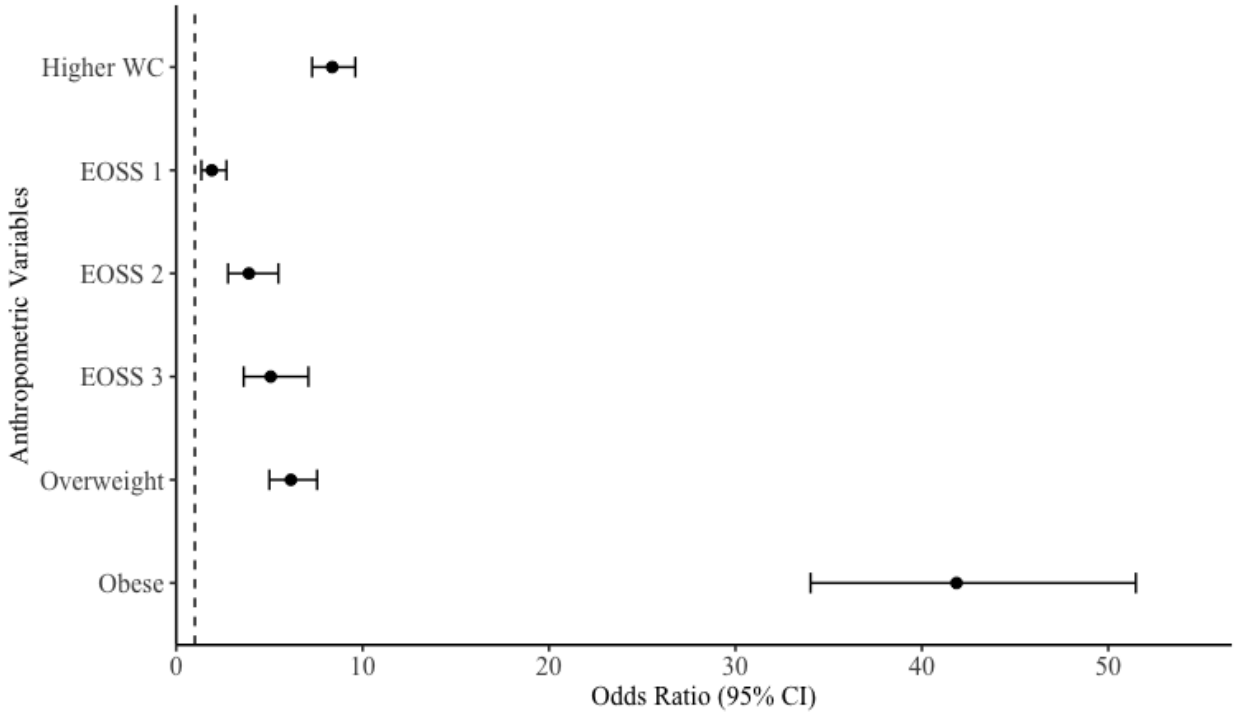

Figure 4. Forest plot of independent anthropometric measurement odds ratio comparison with 95% confidence limits adjusted for socio-demographic and medical characteristics of U.S. adults from NHANES 1999-2018 ever told by a health provider they were overweight

Discussion

Results from this study demonstrate that the number of individuals receiving HCP weight-related messaging has increased over time, suggestive of an increasing awareness of the harms of overweight and obesity. That the patterns observed by subgroup, and predictors of HCP advice have remained relatively constant, suggest that traditional measures of weight such as BMI (rather than more useful anthropometric or clinical tools) continue to be overemphasized in clinical obesity care.

Sociodemographic and Behavioral Patterns

In general, older individuals, females, and those with higher socioeconomic status were each associated with greater likelihood of being told one was overweight. In particular, both males and females experienced parallel rises in being told they were overweight. From 1999–2000 to 2017–2018, men's prevalence climbed from 14.5% to 23.7%, while women's rose from 15.7% to 19.2%. Although women initially reported higher prevalence than men, by 2017–2018 men (23.7%) slightly surpassed women (19.2%) in being told they were overweight. These patterns varied by age, with 45–64 y groups reporting the largest prevalence of weight feedback at 15.8%, compared with 12.1% of those 18–44 years and 7.2% of those ≥ 65 years. These differences were further exaggerated in stratification (7 age groups) where a pattern of decreasing prevalence being told one is overweight was seen in the oldest cohorts, despite absolute increases over time (3.4% in 18–29 year olds to 5.1% (30–39), 7.4% (40–49), and 8.1% (50–59) before declining to 6.9% (60–69), 3.3% (70–79), and just 0.8% in those ≥ 80 (all $p < .0001$)). This pattern likely reflects both growing obesity prevalence and more frequent clinical contact through mid-adulthood, followed by caution against weight-loss interventions in "older"

adults (65y+) where excess weight (where both lean and fat mass) may protect against sarcopenia and malnutrition.[44,45] Age-related changes in body composition also render BMI less sensitive to adiposity in the very old, reducing clinician inclination to discuss weight status as one ages.[46]

To our surprise, ethnicity was not a significant determinant of reported weight-status feedback ($p = 0.1365$), with White adults comprising the vast majority of those told they were overweight (26.5% of the sample) and Hispanic (3.5%), Black (2.9%), and Other (1.9%) groups reporting similarly low rates. Over the ten survey cycles, no non-White group showed a consistent upward or downward trend. These results stand in contrast to smaller studies suggesting that Black and Hispanic individuals may receive less obesity counseling than other groups,[47] but aligns with more recent NHANES analyses finding minimal ethnic differences once clinical risk and healthcare access are accounted for.[48] Possible explanations for this finding include uniform adherence to BMI-based screening across patient populations and the high overall prevalence of overweight in the U.S., which may diminish ethnic differences in providers behavior. Nevertheless, continued monitoring is warranted to ensure that cultural, language, and access barriers do not contribute to under-recognition of excess weight in ethnic minority groups.

In our analysis, 52.6% ($p < .0001$) of those who reported been told they were overweight by an HCP had some college education or above and increased over time (14.8% in 1999–2000 to 24.9% in 2017–2018), whereas rates among individuals without a high-school diploma remained low and relatively unchanged (7.2% to 5.0%; $p > .05$). These findings mirror prior NHANES analyses showing that adults with at least some college education receive weight-management counseling at twice the rate of those with lower educational levels.[36] While there

are many competing explanations, lower rates of HCP advise among individuals with lower educational attainment may reflect differences in health literacy, patient activation/access, and providers communication styles.[48] Socioeconomic and lifestyle factors also appeared to influence the frequency of individuals being told they were overweight: higher-income individuals (PIR >1.85) were more frequently told they were overweight (23.7%) compared to those with lower incomes, whereas both non-smokers and physically active individuals were more likely to have been told they were overweight than smokers and inactive individuals, respectively. These findings suggest that weight-related discussions may be more common among individuals with healthier lifestyle behaviors, either due to i) increased healthcare engagement, or; ii) a "healthy user" bias. It has previously been shown that individuals already engaging in preventive behaviors such as regular exercise may be both more visible to, and more proactive with providers, and thus more likely to receive weight-status feedback., similar to what is seen among White, more educated, and higher income individuals.[49]

As expected, anthropometric and clinical tools were most strongly associated with an individual being told by a HCP that they were overweight. Overall, 8.5% of adults with overweight and 24.9% of those with obesity, compared with 1.6% of normal-weight individuals received this advice. Over the study period, feedback among people with obesity rose steadily from 20.9% to 33.4% ($p < .0001$), while those with overweight BMI peaked at 11.1% ($p < .0001$). Similarly, this advice increased over the study period from 18.1% to 29.6% among those with MetS and from 25.1% to 38.2% ($p < .0001$) among those with a high WC. Finally, individuals identified as Stage 2 or 3 EOSS saw an increase from 22.8% to 27.3%, and 4.5% to 11.9%, respectively ($p < .0001$). Unlike BMI, which measures only mass relative to height, EOSS incorporates comorbidity burden and functional status—and has been shown to predict

mortality independently of BMI and MetS.[43] These trends unfold against a backdrop of rising adiposity, wherein the rate of obesity among U.S. adults increased from 30.5% to 42.4% between 1999 and 2018.[50] Globally, the prevalence of adult obesity has more than doubled since 1990, rising from roughly 8% to over 16% of the world's population by 2022, with nearly 60% of adults expected to have overweight and obesity by 2050.[51] Although clinical vigilance for excess weight has clearly increased, the fact that fewer than one-third of obese adults recall ever being told they were overweight points to ongoing gaps in care.[36] Embedding structured tools like EOSS and automated waist-circumference alerts into electronic health records, together with providers training in weight-status communication, may help ensure that objective risk stratification translates into equitable patient feedback.[52] However, these strategies do not address patient-level biases such as recall bias or self-perception of weight that can influence whether advice is reported or remembered.[53,54,55] It is also possible that changes in overweight, obese, and metabolically at-risk subgroups could suggest a material shift in health-care providers' recognition or at least communication of the health risks associated with excess adiposity over the past two decades. Further qualitative and/or mixed methods research is necessary to better understand the factors responsible for this change.

Exploring predictors of being told they are overweight by a HCP

Similar to findings from the prevalence analysis, results from the unadjusted regressions suggest that demographic and socioeconomic factors are only modestly related to HCP advice, compared to much stronger objective measures of adiposity and cardiometabolic risk. That the odds of HCP advice was highest in 60-69 y olds reflects both intensified midlife weight-status discussions and greater caution in older age groups. In midlife, both higher obesity prevalence

and more frequent providers likely both contribute to the finding of higher recognition of excess weight by HCPs. Beyond age 70 y, odds of HCP weight advice is attenuated, but remains elevated, suggestive of caution against weight-loss recommendations on protective measures in prolonging life, and the declining sensitivity of BMI and waist-circumference measures in the very old.[45] Thus, the OR peak in the 60–69 group likely reflects an optimal balance of risk recognition and intervention opportunity, whereas the subsequent decline underscores the balance between recognizing the protective aspect of elevated weight in older adults, and the prioritization of other higher-risk comorbidities.

Similar to the work of de heer et al.[35] and Greaney et al[36], women had 50% higher odds of reporting that they were told they were overweight compared with men. Unexpectedly, few variations in these patterns across ethnic groups were observed: Hispanic adults had slightly lower odds (OR=0.88, 95% CI: 0.79 – 0.99) compared with White group, while Black and Other groups did not differ significantly. These results accord with other NHANES studies showing minimal adjusted racial/ethnic differences in weight-management counseling,[36] although smaller clinical studies have suggested that Hispanic patients sometimes receive less obesity advice.[46] Educational attainment emerged as a strong predictor: adults with some college or higher had 1.40 times the odds of being told they were overweight versus those without a high-school diploma, echoing evidence that higher health literacy and patient activation facilitate preventive counseling.[56] Income also showed a similar gradient, where individuals with PIR > 1.85 were 16% more likely to report overweight feedback than those with PIR ≤ 1.3, consistent with findings that higher-income adults receive weight-loss advice more frequently.[57] Together, these socioeconomic patterns highlight how patient-providers communication around weight may be

shaped by patients' resources and engagement, and underscore the need for standardized screening prompts and targeted outreach to lower socioeconomic status groups.

In terms of lifestyle factors, regular cigarette smokers had significantly lower odds (OR=0.58) of being told they were overweight compared to non-smokers, while physically active individuals also had lower odds (OR=0.79) compared to those who were inactive. The cross-tabulated frequencies show the opposite for activity: 19.1% of active versus 15.8% of inactive adults reported weight-status feedback. This discrepancy—unadjusted prevalence versus unadjusted odds—highlights how logistic models summarize group differences on a relative scale, while raw percentages reflect absolute prevalence. Both findings nonetheless point to a "healthy-user" pattern, in which patients already engaged in healthier behaviors are more likely to receive, and recall, weight-status discussions.[36,48]

As discussed previously, markers of adiposity and metabolic dysfunction were most strongly related to HCP feedback. The presence of MetS was associated with a nearly five-fold greater odds (OR=4.80, 95% CI: 4.39 – 5.25) of reporting HCP weight advice, which reinforces the strong knowledge (and ease of measurement of) of MetS as a marker of cardiovascular and diabetes risk and its inclusion in weight-management recommendations.[22] Even stronger associations emerged for central adiposity: elevated waist circumference was associated with a twelve -fold higher odds of receiving HCP weight advice (OR=11.71, 95% CI: 10.33 – 13.26) refl;[58] however, in comparison to the associations observed for BMI the effects were more modest. Indeed, in non-specialist settings, BMI remains the backbone of clinical screening for weight related complications, with overweight and obese adults exhibiting roughly 6.5 to over 200-fold higher odds of having been told they were overweight versus "normal weight" peers.[59]

Although a standard threshold of "normal weight" BMI was used in the current analysis, it may under-detect excess adiposity in East and Southeast Asian populations, for whom lower BMI thresholds (e.g. ≥23 kg/m²) better captures cardiometabolic risk.[60] Restricting analyses solely to elevated-BMI groups may therefore overlook these "hidden obesity" cases. Finally, our results reinforce the utility of more wholistic risk assessment approaches for the assessment of obesity-related health risk (by integrating comorbidity burden and functional status, rather than "weight" alone). Notably, EOSS Stage 2 (OR=6.17, 95% CI: 4.40 – 8.65) and Stage 3 (OR=7.04, 95% CI: 5.04 – 0.85) individuals had markedly higher odds of reported feedback as opposed to stage 1 (OR=1.64, 95% CI: 1.16 – 2.32). This finding is reinforced by evidence that EOSS staging more accurately predicts morbidity and mortality than BMI categories alone,[49] and in the current context, suggest that, while simple anthropometric measures drive most weight-status discussions, more work is necessary to incorporate metabolic and functional risk scores such as MetS and EOSS into cardiometabolic and overall health-risk assessments to ensure that individuals with overweight and obesity receive appropriate and timely treatment.

Adjusted comparison of obesity-risk tools and HCP bias

In the final multivariable analyses comparing three obesity-risk tools (BMI, WC, and total EOSS score) can not exclude the possibility of HCP bias through an over-reliance on simple, visible patient measures of "weight". Indeed, our analyses demonstrate that BMI and WC remain the dominant drivers of whether patients report being told they were overweight, even after adjusting for known confounders (age, sex, ethnicity, education, income, smoking, physical activity and MetS status). Individuals with overweight or obesity by BMI were between six and fourty-fold more likely to receive HCP weight advice, and elevated WC had an eight-fold higher

odds, in excess of the strength of the associations for any EOSS stage (EOSS Stage 2 vs Stage 0; OR=3.90, 95% CI: 2.78 – 5.48; Stage 3 vs Stage 0: OR=5.07, 95% CI: 3.62 – 7.09). Taken together, these results suggest that despite growing awareness of the limitations of BMI, it its prominence in research and the general public persists, which may advance its use as a clinical tool to help guide conversations about weight in a patient-providers relationship. While the benefits of comprehensive risk-assessment tools like EOSS are clear, they remain under-utilized in clinical workflows.[49,59] Incorporating automated waist circumference flags and EOSS calculators into electronic health records, along with targeted providers training on comprehensive risk assessment, could lead to a more individualized and clinically relevant assessment. This approach would reveal any obesity-related health problems in higher-risk patients by accurately identifying cardiometabolic and behavioural risk factors for certain demographic groups across all ages, sex, and ethnic groups that may be underrepresented in these discussions.

Study Limitations

A major strength of the current analysis is the purposeful comparison of multiple indices of health; however, as the mental and functional aspects of EOSS are incompletely captured in NHANES, the current analysis focuses exclusively on physical measures of EOSS scoring. This may underestimate (and bias to the null) any relationship between EOSS stage and HCP weight loss advice, and should be a focus of future work. The nature of NHANES questionnaires and the cross-sectional design of the data do not allow any causality or incidence of obesity to be identified, nor can we evaluate any change in “obesity” or weight status across time. Nonetheless, this is the only population-based data available to address the question of interest in the current timeline of obesity education.

In addition, many of the behavioral and sociodemographic exposures of interest are based on self-report, which introduces the possibility of recall and responder bias.[61] Beyond recall bias, the NHANES questionnaires themselves also present limitations: they do not capture the level of HCP training, specialty, or education, which restricts the ability to interpret proportionality in the use of BMI and WC measures across different provider groups. In addition, the survey question "ever told to lose weight" may be subject to respondent interpretation, as individuals could recall and perceive this interaction differently. Such nuances highlight the complexity of patient–provider communication, where phrasing, tone, and context may alter both the delivery and the way advice is internalized. Further, the reliance on self-reported responses introduces the potential for social desirability bias, whereby participants may under- or over-report weight-related advice received depending on their personal attitudes or perceived expectations. Similarly, the calculation of MVPA relied on self-reported minutes of physical activity per week and a dichotomous cut-point of 150 minutes, which may oversimplify the complexity of physical activity behaviors. This approach does not capture intensity, bout duration, or patterns of activity, and may misclassify individuals relative to their true activity levels.

Because NHANES is U.S. national data, it may not reflect current HCP weight advice practices within the U.S. or Canadian settings. Of note, there will be a lag time in the adoption and uptake of clinical practice guidelines and advice.[62] As such, results from the current study will reflect knowledge and direction of HCPs on the clinical practice guidelines available at the time, but not changes to obesity treatment and management recommended in the 2020 *Canadian Adult Obesity Clinical Practice Guidelines* (or other, similar international efforts). Finally, despite the large sample size, it was not possible to apply ethnic-specific BMI and WC thresholds in the current analysis. With the wide spectrum of ethnic groups represented in Canada and the U.S.

which have varied relationships with obesity, the use of uniform anthropometric thresholds for the analysis could have impacted the findings in unexpected ways.

Conclusion

This study provides new data on temporal trends in HCP weight loss advice, and how this advice tracks with patterns of obesity across a period of considerable change in the landscape of patient awareness and HCP education. The findings suggest that as obesity prevalence has risen, the likelihood of individuals with obesity reporting that they were "told to lose weight" has also increased. This highlights both the significance of temporal changes in provider practices and the limitations of relying on a single survey item to capture a nuanced clinical interaction. Indeed, differences in how patients interpret the question "ever told to lose weight" may partly explain why affirmative responses do not perfectly align with population-level obesity trends.

Taken together, these results underscore the need for ongoing evaluation of how weight-related advice is delivered and perceived, and for caution in assuming that quantitative survey responses fully reflect the quality or depth of patient-provider communication. Future work should build on these findings by developing and integrating methods that capture not just *whether* advice was given, but how it was framed and received.

Ultimately, these findings reinforce a broader call for individualized and person-centred care. Weight loss advice, when given, should be delivered in a manner that is sensitive, respectful, and tailored to each patient's context. Equally important, HCPs may consider alternative strategies such as medical supports, information sharing, or referrals that support patient health without relying solely on weight as the central marker of risk. By emphasizing

person-centred approaches, clinicians can help reduce stigma, foster more collaborative patient-provider relationships, and improve long-term health outcomes.

Next Steps

Building on these findings and being mindful of study limitations, several NHANES-based approaches could deepen our understanding and address current study gaps. First, future analyses should incorporate NHANES functional and mental health questionnaires to complete EOSS staging, since our focus on physical components may underestimate its true association.[48] Second, linking NHANES to the National Death Index and longitudinal cohorts would allow examination of whether "told overweight" predicts subsequent weight change, incident cardiometabolic outcomes, or mortality, overcoming the cross-sectional constraints of the current study. Third, leveraging accelerometry and 24-hour dietary recall data (available in select cycles) could validate self-reported physical activity and explore its role in providers' feedback beyond recall bias. Finally, applying ethnic-specific BMI and waist-circumference thresholds, particularly for Asian subpopulations, could identify "hidden" obesity cases missed by standard cut-offs.

Beyond NHANES, future research should also consider study designs that capture the quality of patient–provider interactions, such as incorporating validated measures of communication quality, provider empathy, or shared decision-making. Such approaches could provide insight into how weight-related conversations are initiated, framed, and received across different settings. In addition, examining ideal communication strategies and appropriate interventions such as emphasizing non-weight focused approaches that prioritize medical supports, information sharing, and referrals to appropriate services would help clarify how HCPs

can meet patient needs while avoiding weight-centered stigma. Finally, qualitative studies, including patient and provider interviews, could further explore the dynamics of these interactions, uncovering how advice is delivered, interpreted, and acted upon, and highlighting opportunities for more patient-centered care.

Together, these steps would refine risk stratification, improve causal inference, and ensure equitable assessment of adiposity-related health risk across diverse patient groups, while also advancing understanding of how provider communication can best support long-term obesity management.

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Appendices

Appendix A

Supplementary Figure 5 A–C) Socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018.

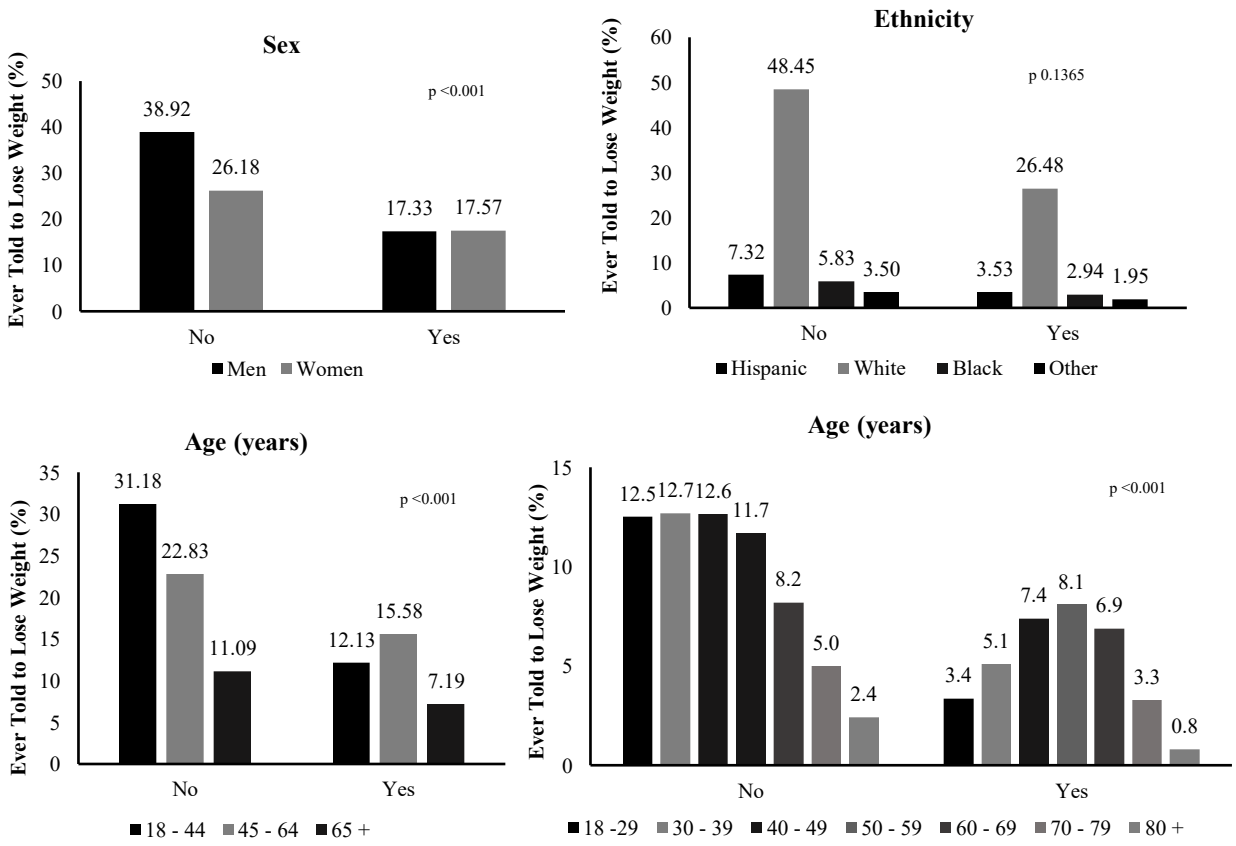


Figure 5 A) Prevalence of U.S. adults being told by a healthcare professional that you were overweight by sex, ethnicity, age category. *****Hispanic: Mexican American, other Hispanic, Other: other race including Multi-Racial

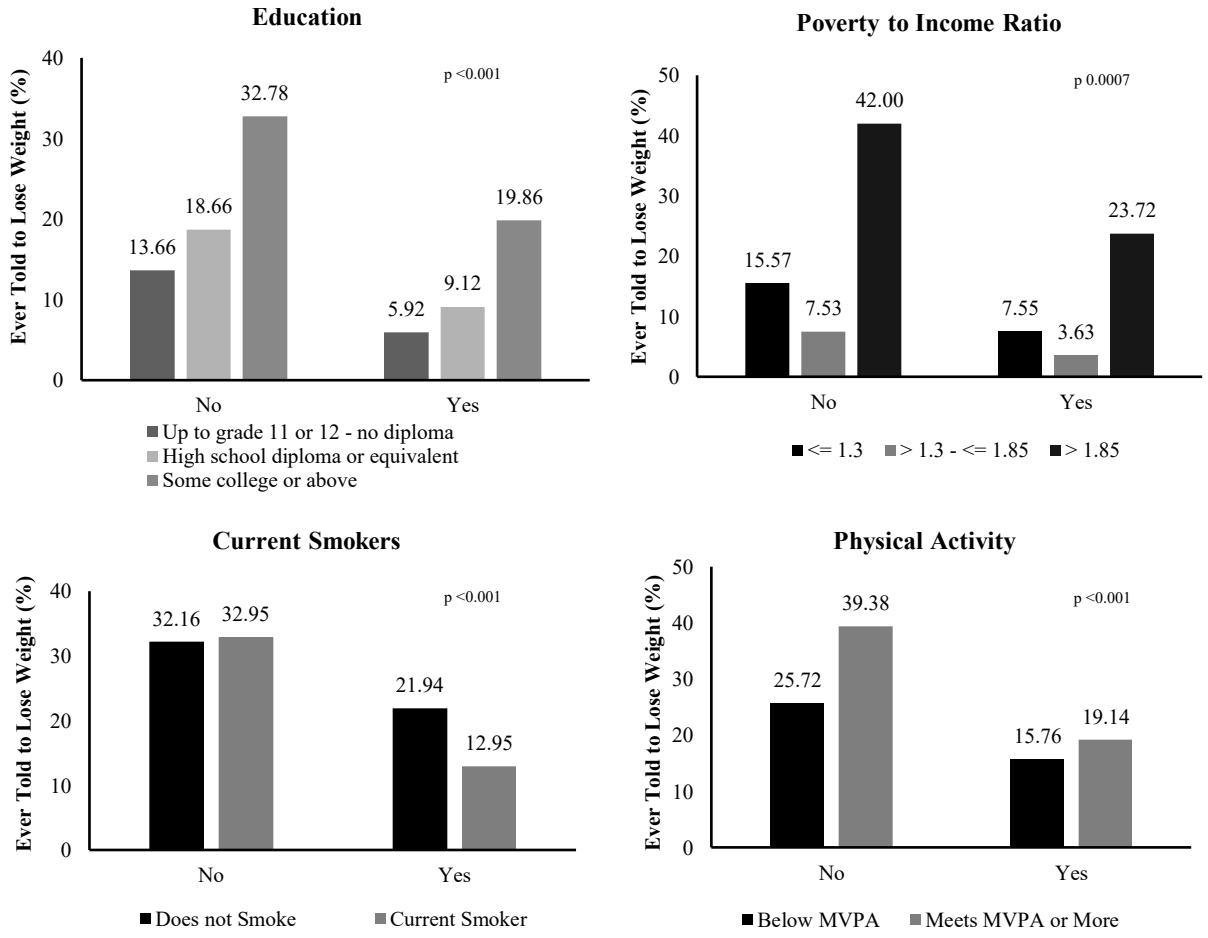


Figure 5 B) Prevalence of U.S. adults being told by a healthcare professional that you were overweight by education, poverty to income ratio, current smokers and physical activity groups.

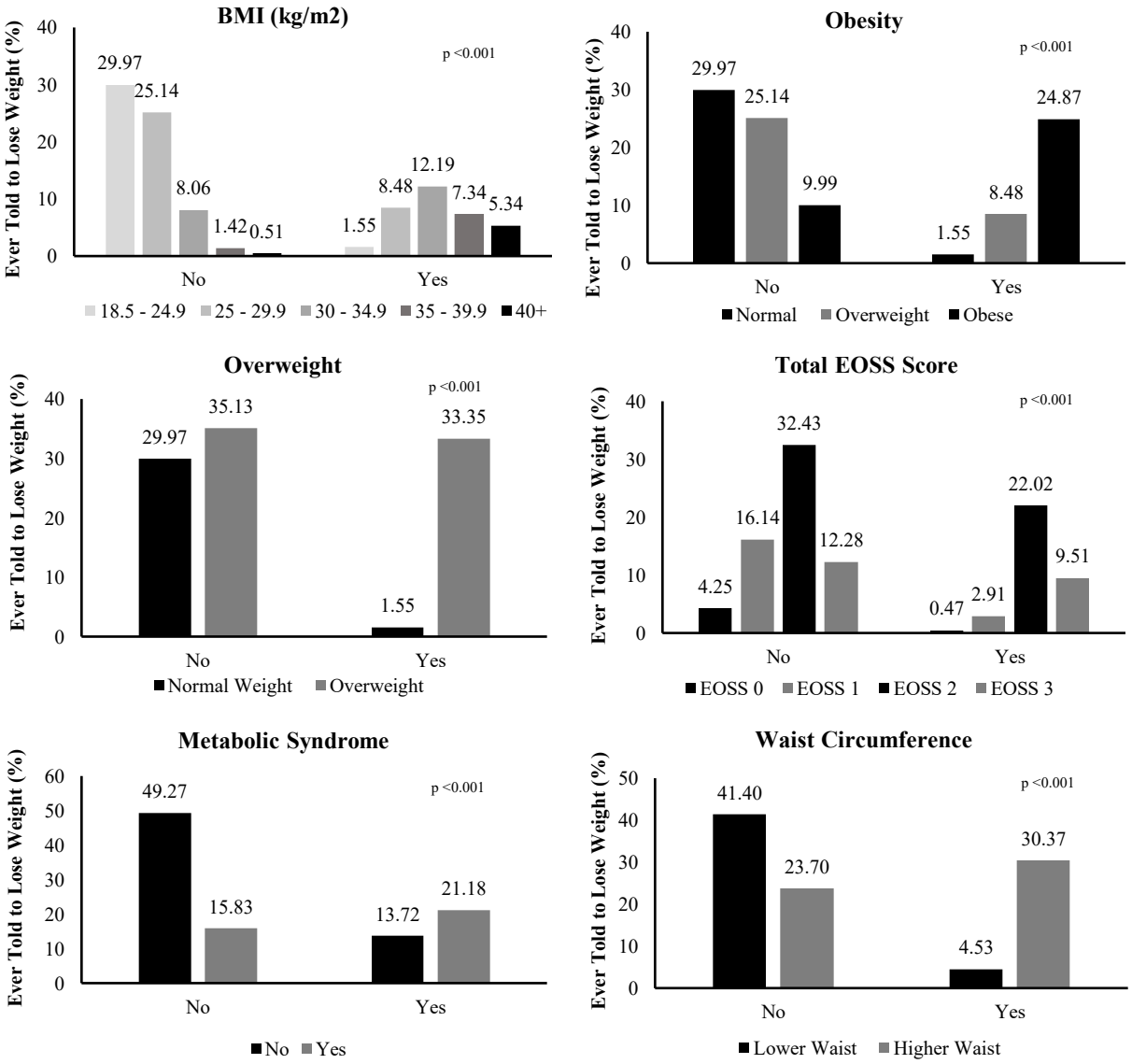


Figure 5 C) Prevalence of U.S. adults being told by a healthcare professional that you were overweight by BMI (body mass index), obesity, overweight significance, total EOSS (Edmonton Obesity Staging System) score, metabolic syndrome, and waist circumference groups.

Supplementary Table 6 A–D) 20-year temporal trends of socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018.

Table 6 A) Temporal trends of socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 for age and sex groups.

Cycle year	1999 - 2000	2001 - 2002	2003 - 2004	2005 - 2006	2007 - 2008	2009 - 2010	2011 - 2012	2013 - 2014	2015 - 2016	2017 - 2018
Age Category (years)										
	No (%)									
18 - 44	36.93	38.47	35.39	33.27	32.11	31.10	28.84	26.40	23.15	26.34
45 - 64	22.00	26.13	25.02	23.91	23.86	21.81	25.45	21.25	21.67	16.64
65 +	10.91	8.70	10.48	11.14	10.46	10.29	12.32	12.34	10.39	14.06
	Yes (%)									
18 - 44	11.06	9.36	10.16	12.28	11.54	12.79	10.37	13.77	13.99	16.11
45 - 64	14.06	12.68	12.99	13.80	15.07	15.58	15.97	18.11	20.12	17.42
65 +	5.03	4.65	5.97	5.60	6.97	8.43	7.05	8.13	10.68	9.43
p-value	<.0001	<.0001	<.0001	0.013	<.0001	0.0001	<.0001	0.0013	0.0082	0.0053
Age Group Stratified (years)										
	No (%)									
18 -29	13.00	14.22	13.71	14.32	14.00	13.61	10.82	10.45	9.54	11.30
30 - 39	17.51	16.18	14.17	13.30	11.80	11.18	11.88	11.11	9.21	10.71
40 - 49	13.98	16.77	15.62	14.59	13.10	11.82	12.40	10.37	8.85	8.62
50 - 59	11.01	12.92	11.99	11.12	12.73	11.30	13.83	11.17	12.58	8.05
60 - 69	6.49	7.04	8.04	7.43	7.57	7.64	9.51	9.38	8.45	10.19
70 - 79	5.52	4.42	4.98	5.59	4.51	5.17	5.23	5.05	4.32	5.36
80 +	2.34	1.76	2.39	1.97	2.70	2.48	2.94	2.46	2.27	2.79
	Yes (%)									
18 -29	3.06	2.19	3.05	3.06	3.22	4.14	2.46	4.31	3.47	4.82
30 - 39	4.95	3.70	3.78	4.36	5.00	5.20	4.40	5.61	7.05	7.04
40 - 49	6.58	6.95	7.33	9.10	6.83	7.28	7.24	7.37	7.69	7.36
50 - 59	6.95	6.48	6.68	6.37	8.21	8.44	8.36	9.64	10.65	9.05
60 - 69	6.08	4.31	4.79	5.65	6.20	6.84	6.75	8.58	10.82	9.00
70 - 79	2.05	2.52	2.94	2.55	3.53	3.67	3.54	3.37	3.95	4.62
80 +	0.48	0.55	0.53	0.59	0.58	1.23	0.64	1.13	1.15	1.08
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	0.0002	<.0001	0.0154
Sex										
	No (%)									
Male	42.21	42.89	41.29	39.95	39.65	35.73	41.57	35.65	33.47	36.87
Female	27.64	30.41	29.60	28.37	26.77	27.47	25.05	24.34	21.75	20.17
	Yes (%)									
Male	14.46	13.08	14.83	14.99	16.53	18.16	15.67	19.49	22.46	23.75
Female	15.70	13.61	14.29	16.69	17.05	18.63	17.71	20.52	22.33	19.22
p-value	<.0001	0.0004	0.014	0.0006	<.0001	0.036	<.0001	0.0004	0.0236	0.0222

Table 6 B) Temporal trends of socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by ethnicity, education and poverty to income ratio groups.

Cycle year	1999 - 2000	2001 - 2002	2003 - 2004	2005 - 2006	2007 - 2008	2009 - 2010	2011 - 2012	2013 - 2014	2015 - 2016	2017 - 2018
Ethnicity										
	No (%)									
Hispanic*	9.58	8.65	7.61	5.93	7.16	7.15	7.26	6.40	6.95	6.81
White	53.16	55.69	53.78	53.84	49.89	47.27	49.49	42.55	38.01	40.67
Black	5.36	6.14	6.11	5.72	5.83	5.69	5.60	6.75	6.11	4.87
Other*	1.74	2.82	3.39	2.83	3.55	3.10	4.26	4.29	4.14	4.68
	Yes (%)									
Hispanic*	3.35	2.73	2.54	2.02	3.12	3.22	4.05	4.29	4.70	5.46
White	23.41	21.53	22.45	25.46	26.31	28.12	24.73	30.75	33.30	28.68
Black	2.31	1.70	2.60	2.75	2.76	3.71	2.89	3.25	3.73	3.70
Other*	1.09	0.74	1.53	1.45	1.39	1.74	1.71	1.71	3.05	5.13
p-value	0.666	0.1417	0.6559	0.3795	0.5351	0.5242	0.8182	0.0289	0.1232	0.1034
Education										
	No (%)									
Up to grade 11 or 12 - no diploma	17.44	15.72	14.40	13.52	15.99	14.21	14.45	12.78	9.62	8.86
High school diploma or equivalent	21.35	21.75	20.79	19.44	19.12	17.18	15.35	16.27	16.12	19.36
Some college or above	31.06	35.83	35.69	35.37	31.31	31.81	36.82	30.94	29.47	28.82
	Yes (%)									
Up to grade 11 or 12 - no diploma	7.21	4.95	5.35	4.98	8.29	7.71	5.31	5.80	4.97	5.02
High school diploma or equivalent	8.10	8.00	8.49	8.14	7.46	9.37	7.46	9.90	11.33	13.01
Some college or above	14.84	13.75	15.27	18.56	17.83	19.71	20.61	24.31	28.49	24.93
p-value	0.3252	0.6016	0.6166	0.0282	0.0951	0.404	0.2017	0.0013	0.0037	0.0837
Income PIR										
	No (%)									
≤ 1.3	17.30	14.69	16.08	12.64	16.75	16.60	17.24	17.89	13.13	13.73
> 1.3 – ≤ 1.85	8.34	9.04	7.01	7.49	6.46	8.27	7.10	6.35	8.67	6.64
> 1.85	44.20	49.57	47.80	48.19	43.21	38.33	42.28	35.75	33.41	36.67
	Yes (%)									
≤ 1.3	6.47	5.02	5.61	4.96	6.23	7.65	9.67	10.45	8.65	10.99
> 1.3 – ≤ 1.85	3.85	2.36	3.19	2.78	3.38	4.68	4.29	3.52	4.11	4.38
> 1.85	19.83	19.32	20.32	23.94	23.97	24.47	19.43	26.03	32.02	27.60
p-value	0.6435	0.0533	0.4394	0.054	0.0241	0.0238	0.2736	0.1791	<.0001	0.52

*Hispanic: Mexican American, other Hispanic, Other: other race including Multi-Racial

Table 6 C) Temporal trends of socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by smoking, physical activity, metabolic syndrome, and higher waist circumference groups.

Cycle year	1999 - 2000	2001 - 2002	2003 - 2004	2005 - 2006	2007 - 2008	2009 - 2010	2011 - 2012	2013 - 2014	2015 - 2016	2017 - 2018
Smoking										
	No (%)									
Doesn't Smoke	31.94	34.21	34.01	32.03	31.51	32.48	33.57	30.45	29.49	31.75
Smokes Currently	37.90	39.09	36.88	36.29	34.92	30.73	33.05	29.54	25.72	25.29
	Yes (%)									
Doesn't Smoke	18.33	16.86	16.37	18.59	21.29	23.22	22.50	24.56	29.09	28.85
Smokes Currently	11.83	9.84	12.75	13.09	12.29	13.58	10.89	15.45	15.70	14.12
p-value	<.0001	<.0001	0.002	<.0001	<.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Physical Activity										
	No (%)									
Inactive	34.37	39.82	38.77	32.37	19.80	19.36	19.18	20.64	16.78	15.31
Active	35.47	33.48	32.12	35.95	46.62	43.85	47.43	39.35	38.43	41.73
	Yes (%)									
Inactive	15.18	14.73	16.34	15.02	14.17	15.45	14.75	18.86	16.79	16.16
Active	14.97	11.97	12.78	16.66	19.40	21.34	18.63	21.15	28.00	26.81
p-value	0.7991	0.7896	0.6436	0.9885	<.0001	<.0001	<.0001	0.0048	0.0504	0.0012
Metabolic syndrome										
	No (%)									
No MetS	55.00	57.40	55.81	53.33	48.10	48.57	49.75	44.08	38.57	42.06
Yes MetS	14.84	15.91	15.07	14.99	18.32	14.63	16.86	15.92	16.65	14.97
	Yes (%)									
No MetS	12.03	10.30	12.72	13.31	12.86	17.06	12.22	14.87	18.50	13.39
Yes MetS	18.12	16.40	16.39	18.37	20.72	19.73	21.16	25.13	26.29	29.58
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Higher Waist Circumference*										
	No (%)									
Lower WC	48.19	50.58	45.95	45.03	41.23	39.52	41.55	36.02	31.67	34.32
Higher WC	21.66	22.72	24.94	23.29	25.19	23.68	25.06	23.97	23.54	22.72
	Yes (%)									
Lower WC	5.05	4.10	3.24	4.39	5.01	5.59	3.69	4.28	5.37	4.79
Higher WC	25.11	22.60	25.88	27.28	28.57	31.20	29.69	35.73	39.42	38.17
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

*Lower waist circumference: Female <88 cm, Male <102cm; Higher waist circumference: Female ≥88 cm, Male ≥102cm.

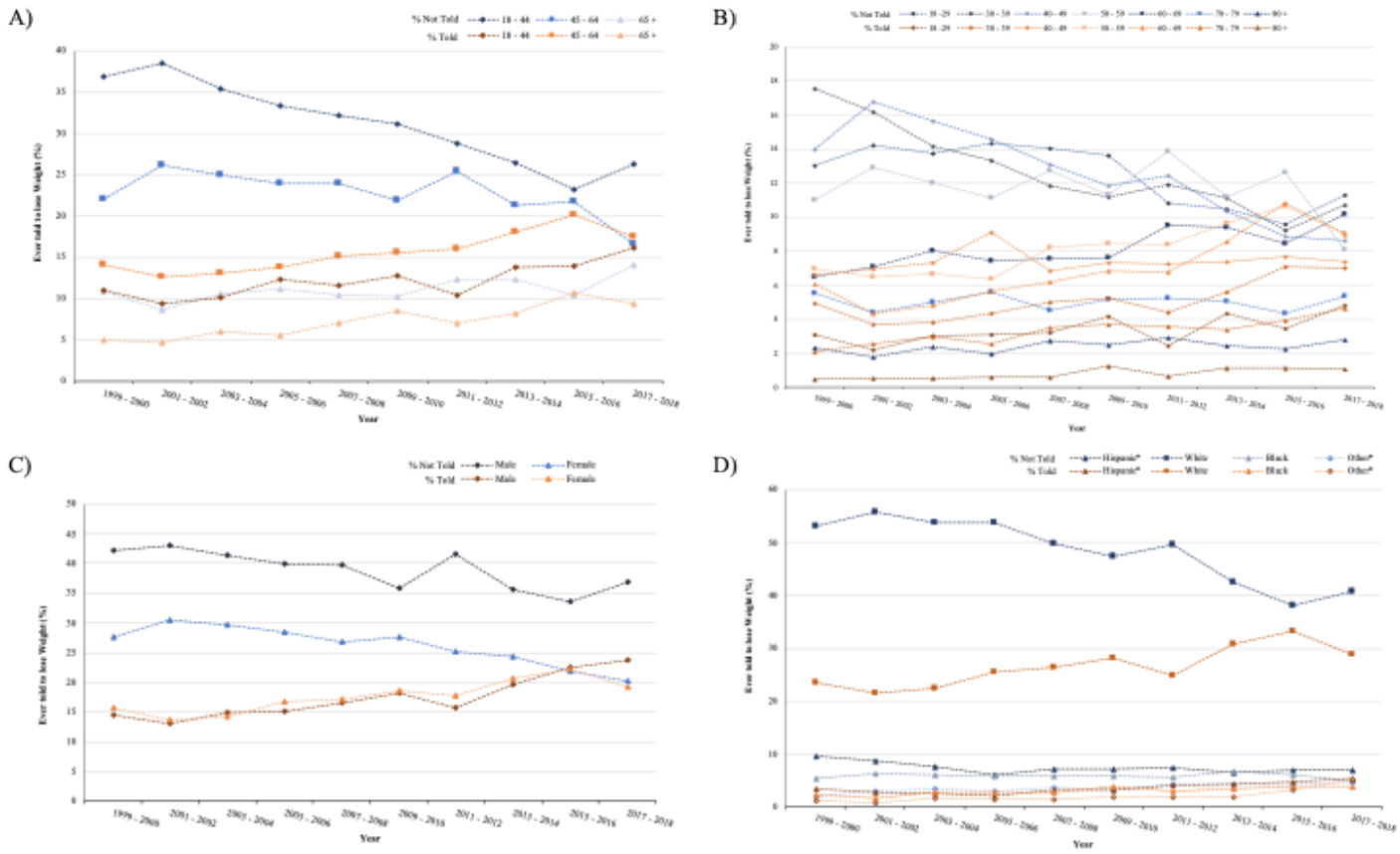
Table 6 D) Temporal trends of socio-demographic and clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by body mass index, obesity, and total EOSS Score groups.

Cycle year	1999 - 2000	2001 - 2002	2003 - 2004	2005 - 2006	2007 - 2008	2009 - 2010	2011 - 2012	2013 - 2014	2015 - 2016	2017 - 2018
Body Mass Index Class (kg/m2)										
	No (%)									
18.5 - 24.9	34.53	34.73	33.57	33.31	30.83	29.16	31.04	25.92	23.77	22.88
25 - 29.9	28.02	29.31	27.08	25.01	25.61	24.28	24.87	24.37	20.28	22.66
30 - 34.9	5.43	7.52	8.87	7.64	8.49	7.36	8.65	8.00	8.67	9.67
35 - 39.9	1.57	1.04	1.06	1.54	1.23	1.94	1.49	1.37	1.62	1.40
40+	0.29	0.69	0.30	0.82	0.26	0.47	0.56	0.34	0.88	0.43
	Yes (%)									
18.5 - 24.9	1.17	1.56	1.22	1.93	1.50	2.37	0.91	1.52	1.71	1.56
25 - 29.9	8.07	6.85	7.89	7.47	8.56	7.95	8.97	9.81	11.19	8.01
30 - 34.9	11.16	9.78	10.68	10.96	11.77	13.27	10.98	13.15	15.37	14.97
35 - 39.9	6.62	4.68	5.60	7.34	7.69	8.09	7.58	7.90	9.55	8.49
40+	3.14	3.82	3.74	3.98	4.05	5.11	4.94	7.64	6.96	9.92
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Obesity										
	No (%)									
Normal	34.53	34.73	33.57	33.31	30.83	29.16	31.04	25.92	23.77	22.88
Overweight	28.02	29.31	27.08	25.01	25.61	24.28	24.87	24.37	20.28	22.66
Obese	7.30	9.26	10.24	10.00	9.98	9.77	10.70	9.70	11.16	11.50
	Yes (%)									
Normal	1.17	1.56	1.22	1.93	1.50	2.37	0.91	1.52	1.71	1.56
Overweight	8.07	6.85	7.89	7.47	8.56	7.95	8.97	9.81	11.19	8.01
Obese	20.92	18.29	20.01	22.27	23.52	26.47	23.50	28.69	31.88	33.39
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Total EOSS Score										
	No (%)									
EOSS 0	4.14	5.56	5.33	6.54	2.69	3.72	3.38	3.18	4.48	3.20
EOSS 1	19.17	22.91	21.27	17.29	15.33	14.82	11.44	12.44	11.03	15.52
EOSS 2	41.12	39.03	37.31	35.71	25.16	24.97	28.42	33.88	29.87	28.83
EOSS 3	5.42	5.79	6.97	8.78	23.24	19.70	23.38	10.49	9.83	9.48
	Yes (%)									
EOSS 0	0.3	0.5	0.3	0.8	0.2	0.4	0.5	0.5	1.0	0.1
EOSS 1	2.5	2.4	2.9	2.7	2.8	3.2	1.7	3.8	3.5	3.6
EOSS 2	22.8	18.8	20.8	21.6	17.8	19.6	17.3	24.6	29.8	27.3
EOSS 3	4.5	5.1	5.1	6.6	12.8	13.6	13.9	11.0	10.5	12.0
p-value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

Appendix B

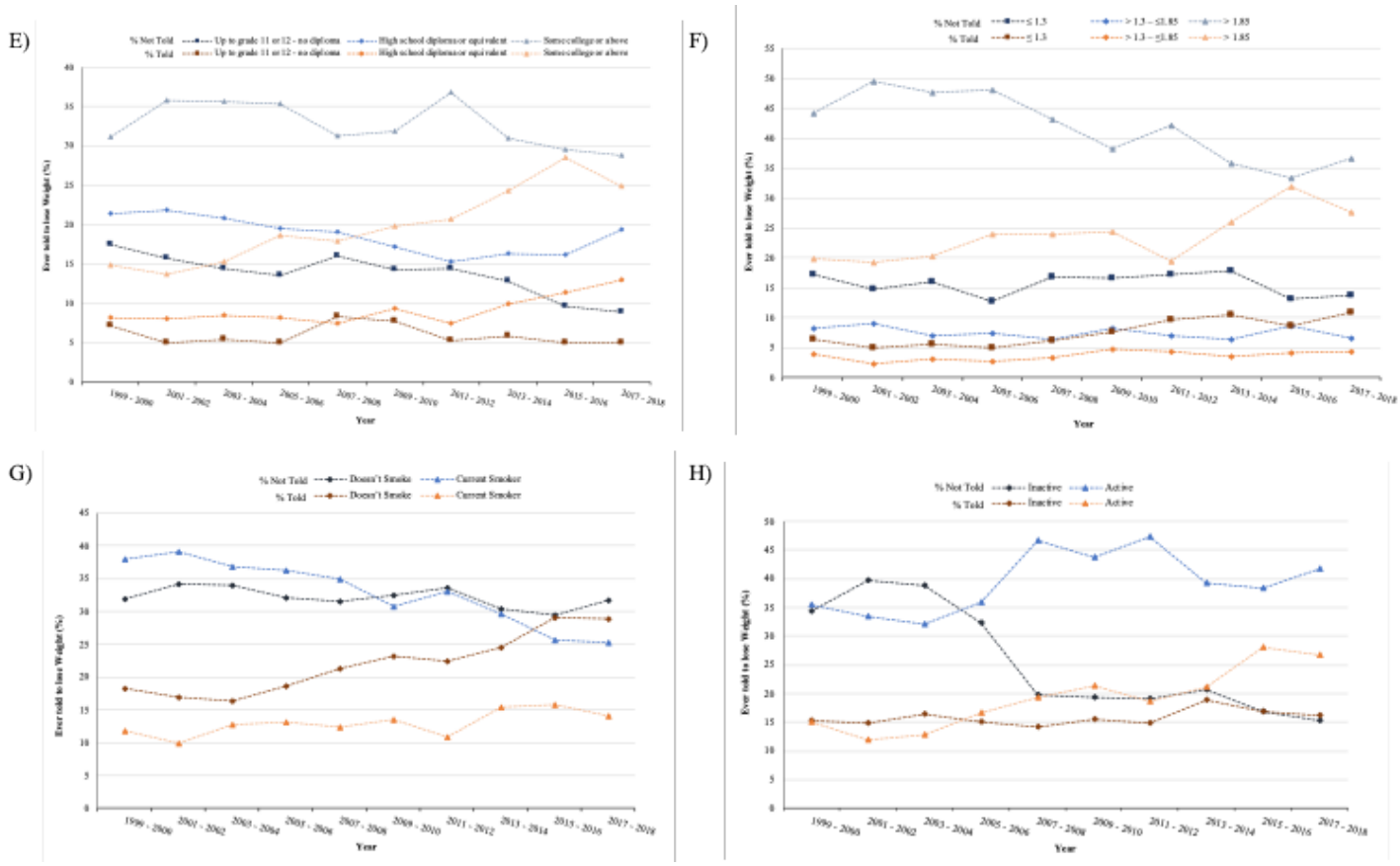
Supplementary Figure 6 A–H. 20-year temporal trends of socio-demographic characteristic prevalence of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018.

Figure 6A–D): Temporal trends of socio-demographic characteristic prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by age category (A, B), sex groups (C), and ethnicity (D) groups.



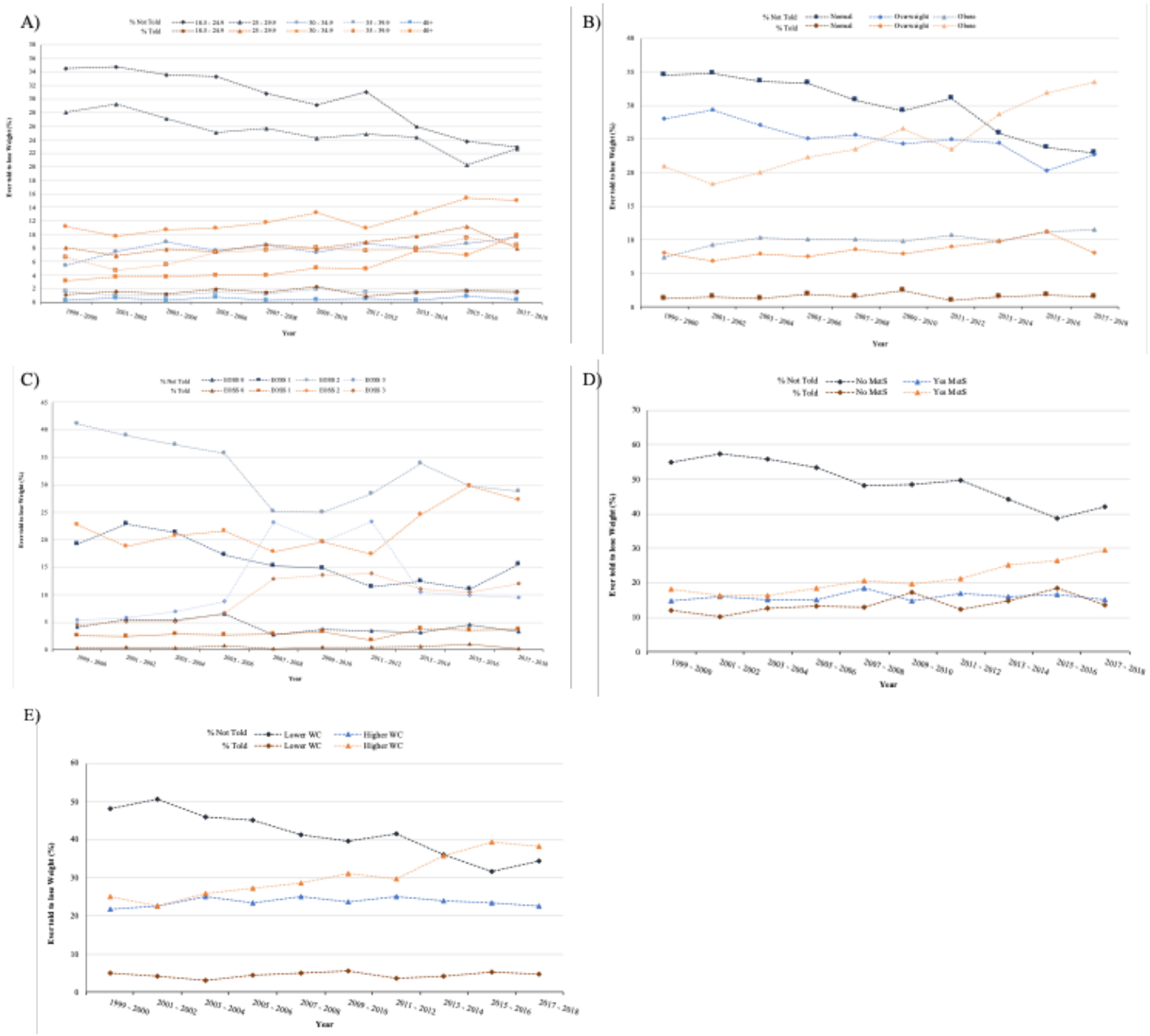
*Hispanic: Mexican American, other Hispanic, Other: other race including multi-racial

Figure 6E–H): Temporal trends of socio-demographic characteristic prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by education (E), poverty to income ratio (F), smoking status (G), and physical activity (H).



Supplementary Figure 7. 20-year temporal trends of clinical characteristic prevalence of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018.

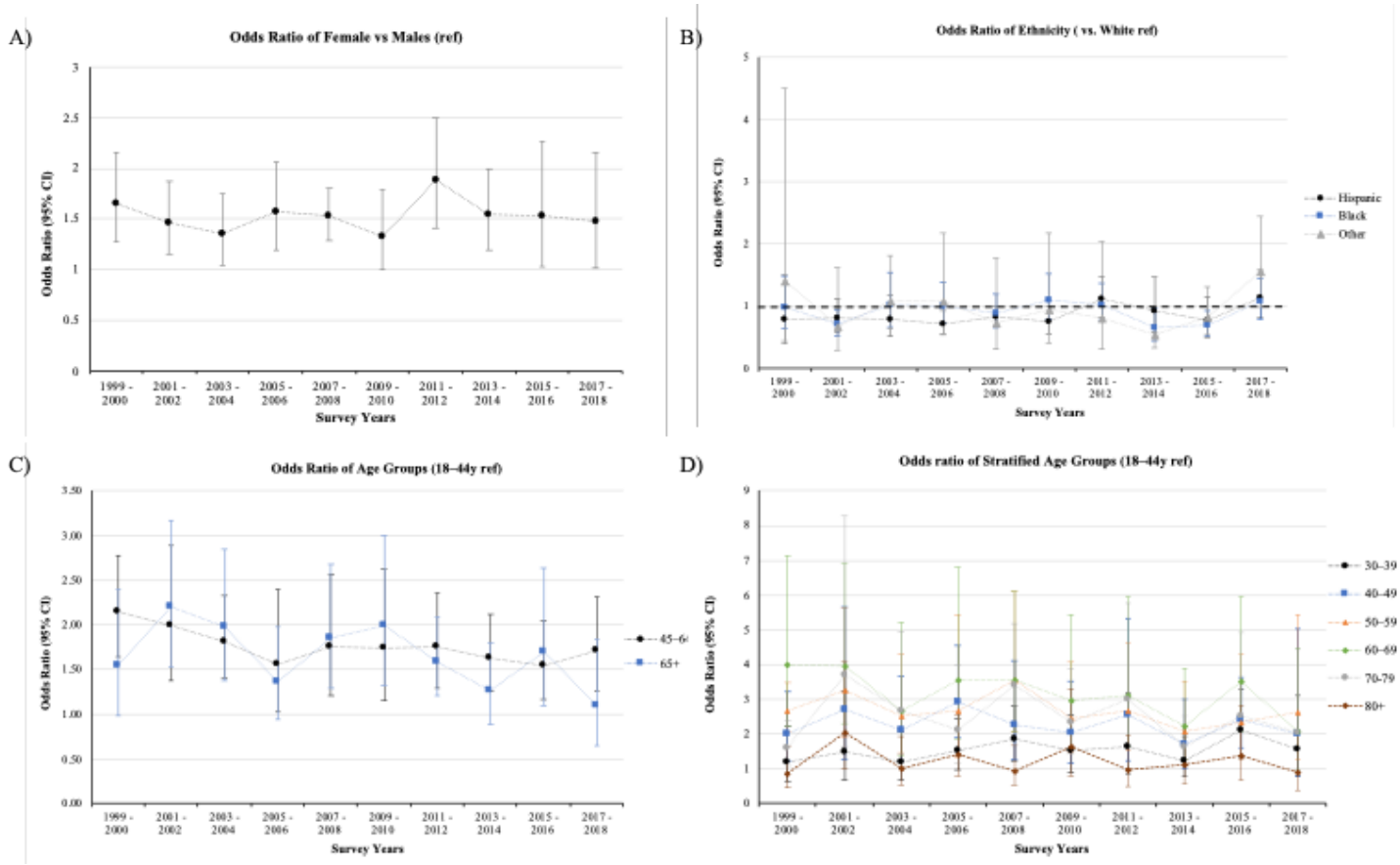
Figure 7. Temporal trends of clinical prevalence of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by body mass index class (A), obesity (B), total EOSS score (C), metabolic syndrome (D), and higher waist circumference (E).



Abbreviations: Edmonton Obesity Staging System, MetS: Metabolic Syndrome, WC: Waist circumference.

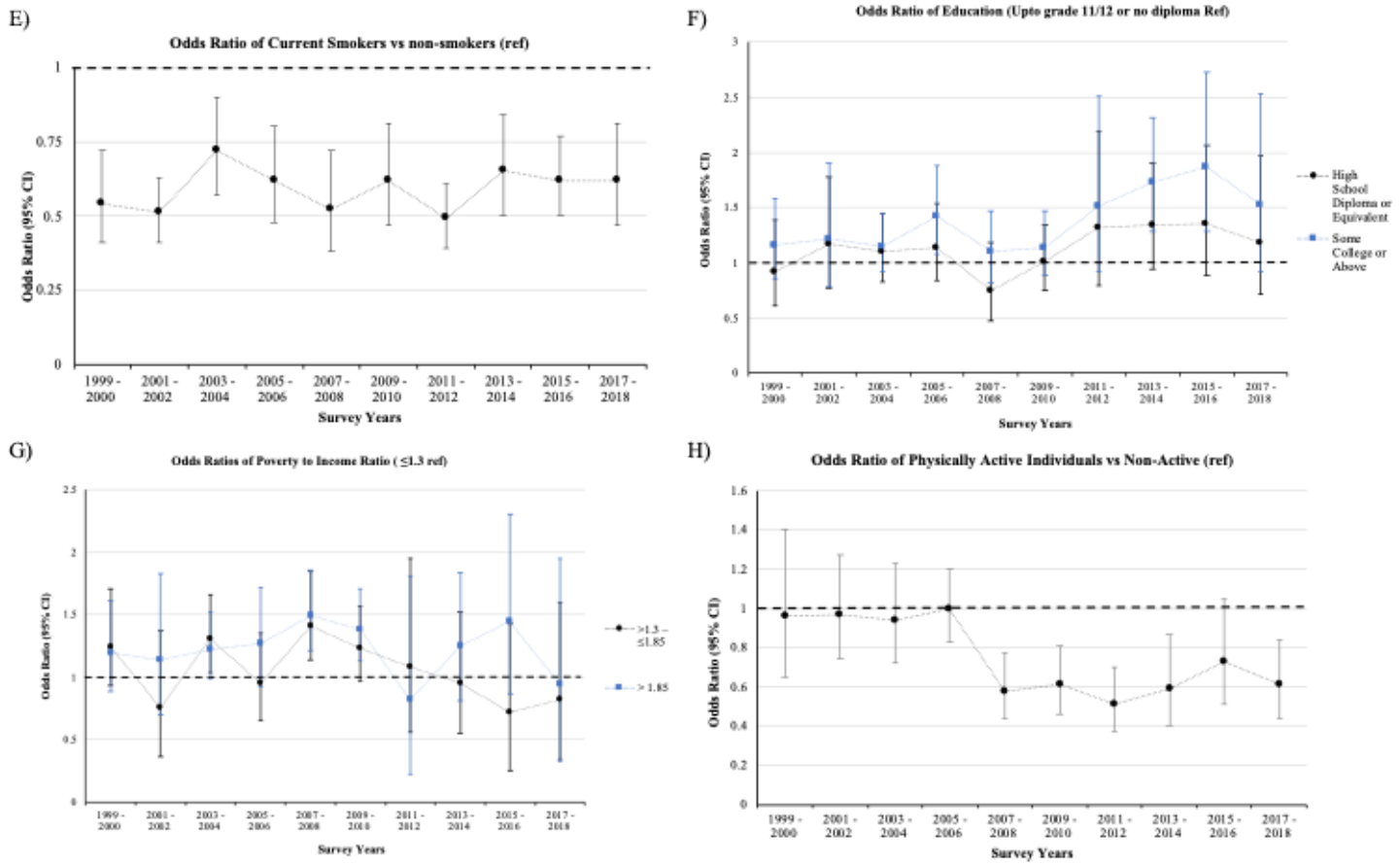
Supplementary Figure 8. 20-year temporal trends of socio-demographic characteristics predicting odd ratio of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018.

Figure 8A–D): Temporal trends of socio-demographic characteristic odd ratio of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by sex (A), ethnicity (B), age category (C) and stratified age group (D).



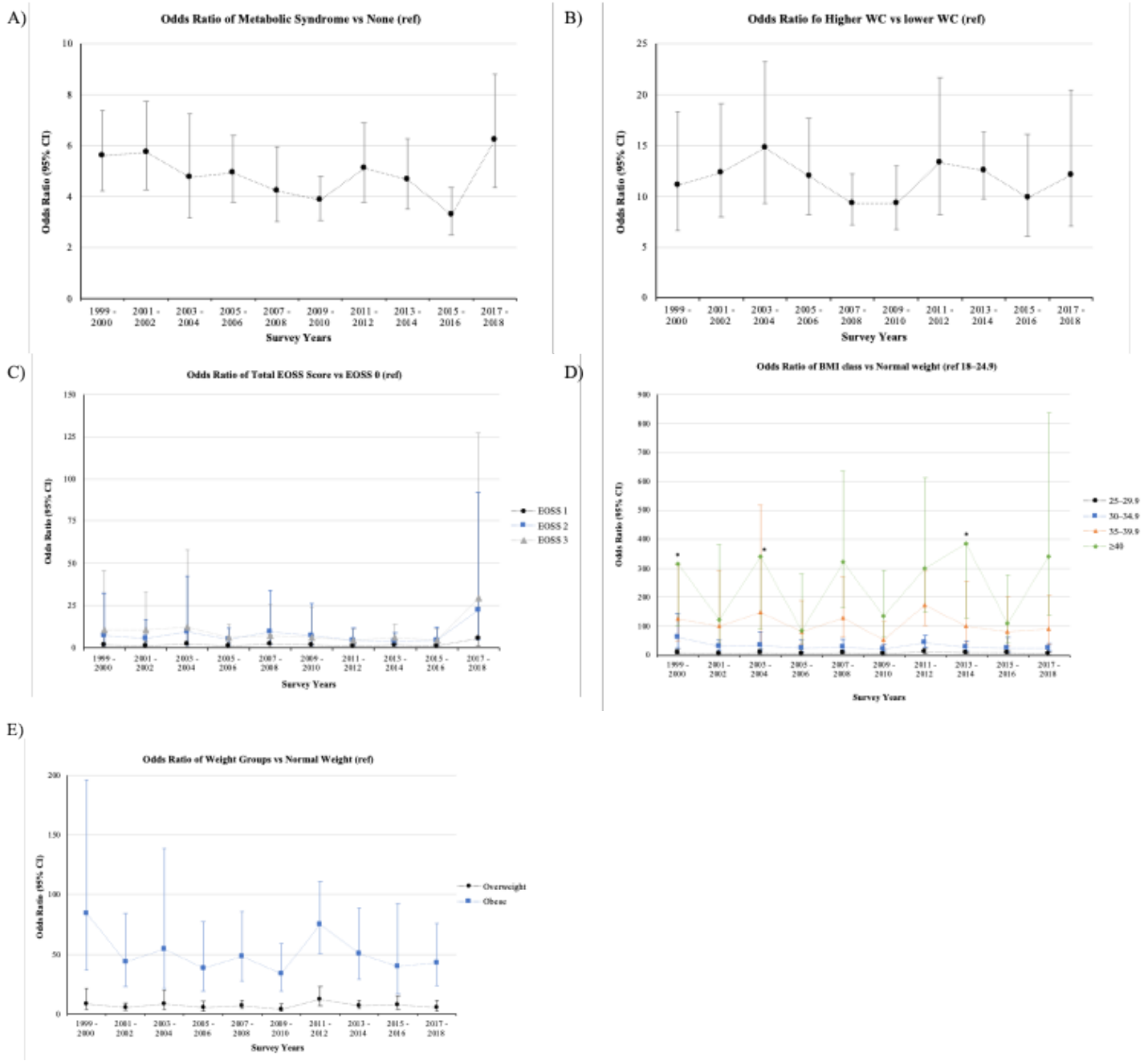
*Hispanic: Mexican American, other Hispanic, Other: other race including multi-racial.

Figure 8E–H): Temporal trends of socio-demographic characteristic odd ratio of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by smoking status (E), education (F), poverty to income ratio (G), and physical activity (H).



Supplementary Figure 9. 20-year temporal trends of clinical characteristics predicting odd ratio of U.S. adults being told by a healthcare professional that you were overweight NHANES during 1999 – 2018.

Figure 9. Temporal trends of clinical predictors of U.S. adults being told by a healthcare professional that you were overweight from NHANES during 1999 – 2018 by metabolic syndrome (A), waist circumference (B), total EOSS score (C), BMI class (D), and overall weight class (E).



Abbreviations: EOSS: Edmonton Obesity Staging System, WC: Waist circumference.
* Upper 95% CI truncated at >999.99 due to sparse data.

Appendix C

SAS EOSS coding:

```
/***** EOSS CATEGORIES ******/


*ARTHRITIS

MCQ160A                 Doctor ever said you had arthritis

MCQ190                  Which type of arthritis

1     Rheumatoid arthritis
2     Osteoarthritis
3     Other

MCQ191                  Which type of arthritis was it?

1     Rheumatoid arthritis
2     Osteoarthritis
3     Psoriatic arthritis
4     Other
7     Refused
9     Don't know

MCQ195                  Which type of arthritis was it?

1     Osteoarthritis or degenerative arthritis
2     Rheumatoid arthritis
3     Psoriatic arthritis
4     Other
7     Refused
9     Don't know
;

Arthritis = .;

if MCQ160A = 2 then Arthritis = 0;
if MCQ160A = . then Arthritis = .;

if MCQ190 = 1 or MCQ190 = 3 then Arthritis = 0;
if MCQ190 = 2 then Arthritis = 1;  *osteo;
if MCQ190 = . then Arthritis = .;

if MCQ191 =1 or MCQ191 = 3 or MCQ191 = 4 then Arthritis = 0;
if MCQ191 = 2 then Arthritis = 1; *osteo;
if MCQ191 = . then Arthritis = .;

if MCQ195 <=4 and MCQ195 >=2 then Arthritis = 0;
if MCQ195 = 1 then Arthritis = 1; *osteo + degenerative;
if MCQ195 = . then Arthritis = .;
```

```
*JOINT PAIN/MOBILITY

MPQ010                  Joint pain/aching/stiffness in past year
MPQ030                  Symptoms begin only because of injury
;

MobilityPain =.;

if MPQ010 = 1 then MobilityPain = 1;
if MPQ010 = 2 then MobilityPain = 0;
if MPQ030 = 1 then MobilityPain = 0;
if MPQ030 = . then MobilityPain = .;


*GOUT

MCQ160N                 Doctor ever told you that you had gout?
;

Gout = .;

if MCQ160N = 1 then Gout = 1;
if MCQ160N = 2 then Gout = 0;
if MCQ160N = . then Gout = .;


*COPD

MCQ160O                 Ever told you had COPD?
SPDBRONC          Selected for Bronchodilator
;

COPD = .;

if MCQ160O = 1 then COPD = 1;
if MCQ160O = 2 then COPD = 0;
if MCQ160O = . then COPD = .;

if SPDBRONC = 1 then COPD = 1;
if SPDBRONC = 2 then COPD = 0;
if SPDBRONC = . then COPD = .;


*** Cardiovascular ***

MCQ160B                 Ever told had congestive heart failure
MCQ160C                 Ever told you had coronary heart disease
MCQ160D                 Ever told you had angina/angina pectoris
MCQ160E                 Ever told you had heart attack
MCQ160F                 Ever told you had a stroke
;

*Heart Failure;

CHF = .;
if MCQ160B = 1 then CHF = 1;
if MCQ160B = 2 then CHF = 0;
```

```
if MCQ160B > 3 then CHF = .;
if MCQ160B = . then CHF = .;

*Coronary Artery/heart Disease;

CAD = .;
if MCQ160C = 1 then CAD = 1;
if MCQ160C = 2 then CAD = 0;
if MCQ160C > 3 then CAD = .;
if MCQ160C = . then CAD = .;

*Chest Pain;

Angina = .;
if MCQ160D = 1 then Angina = 1;
if MCQ160D = 2 then Angina = 0;
if MCQ160D > 3 then Angina = .;
if MCQ160D = . then Angina = .;

*Heart attack;

STEMI = .;
if MCQ160E = 1 then STEMI = 1;
if MCQ160E = 2 then STEMI = 0;
if MCQ160E > 3 then STEMI = .;
if MCQ160E = . then STEMI = .;

*Stroke;

Stroke = .;
if MCQ160F = 1 then Stroke = 1;
if MCQ160F = 2 then Stroke = 0;
if MCQ160F > 3 then Stroke = .;
if MCQ160F = . then Stroke = .;


*Fatty Liver

MCQ510A                 Liver condition: Fatty liver  (2017-2018 only)
;

FattyLiver = .;
if MCQ510A = 0 then FattyLiver = 0;
if MCQ510A = 1 then FattyLiver = 1;
if MCQ510A > 1 then FattyLiver = .;
if MCQ510A = . then FattyLiver = .;


*WEIGHT HISTORY

WHD110                  Self-reported weight-10 yrs ago (pounds)
(weight history 36 years and older for the 10 year)
;

Weighthx1yr = .;
Weighthx10yr = .;
```

```
if WHD050 >1000 then WHD050 = .;
if WHD110 >1000 then WHD110 =.;

Weighthx1yr =.;
Weighthx1yr = WHD050 /2.205;

if WHD050 > 700 then Weighthx1yr = .;

uWeighthx1yr = .;
uWeighthx1yr = Weighthx1yr;

if WHQ070 =1 then uWeighthx1yr = .;
Weighthx10yr = WHD110 /2.205;

if WHD110 > 700 then Weighthx10yr = .;



                /*****DEPRESSION ******/


Depression = .;

Depressionscore = .;

if DPQ010 > 4 then DPQ010 = .;

sDPQ010 = .;

if DPQ010 >=2 and DPQ010 <=4 then sDPQ010 =1;
If DPQ010 < 2 then sDPQ010 =0;
If DPQ010 =. then sDPQ010 =.;

if DPQ020 > 4 then DPQ020 = .;

sDPQ020 = .;

if DPQ020 >=2 and DPQ020 <=4 then sDPQ020 =1;
If DPQ020 < 2 then sDPQ020 =0;
If DPQ020 = . then sDPQ020 =.;

if DPQ030 > 4 then DPQ030 = .;

sDPQ030 = .;

if DPQ030 >=2 and DPQ030 <=4 then sDPQ030 =1;
If DPQ030 < 2 then sDPQ030 =0;
If DPQ030 = . then sDPQ030 =.;

if DPQ040 > 4 then DPQ040 = .;

sDPQ040 = .;

if DPQ040 >=2 and DPQ040 <=4 then sDPQ040 =1;
If DPQ040 < 2 then sDPQ040 =0;
If DPQ040 = . then sDPQ040 =.;
```

```
if DPQ050 > 4 then DPQ050 = .;

sDPQ050 = .;

if DPQ050 >=2 and DPQ050 <=4 then sDPQ050 =1;
If DPQ050 < 2 then sDPQ050 =0;
If DPQ050 = . then sDPQ050 =.;

if DPQ060 > 4 then DPQ060 = .;

sDPQ060 = .;

if DPQ060 >=2 and DPQ060 <=4 then sDPQ060 =1;
If DPQ060 < 2 then sDPQ060 =0;
If DPQ060 = . then sDPQ060 =.;

if DPQ070 > 4 then DPQ070 = .;

sDPQ070 = .;

if DPQ070 >=2 and DPQ070 <=4 then sDPQ070 =1;
If DPQ070 < 2 then sDPQ070 =0;
If DPQ070 = . then sDPQ070 =.;

if DPQ080 > 4 then DPQ080 = .;

sDPQ080 = .;

if DPQ080 >=2 and DPQ080 <=4 then sDPQ080 =1;
If DPQ080 < 2 then sDPQ080 =0;
If DPQ080 = . then sDPQ080 =.;

if DPQ090 > 4 then DPQ090 = .;

sDPQ090 = .;

if DPQ090 >=2 and DPQ090 <=4 then sDPQ090 =1;
If DPQ090 < 2 then sDPQ090 =0;
If DPQ090 = . then sDPQ090 =.;

Depressionscore = Sum
(sDPQ010,sDPQ020,sDPQ030,sDPQ040,sDPQ050,sDPQ060,sDPQ070,sDPQ080,sDPQ090);

If depressionscore ^=. then do;

if depressionscore >= 5 and DPQ010 >1 or DPQ020 >1 then depression = 2;
/*Major depression*/
else if depressionscore >=2 and depressionscore <5 and DPQ010 >1 or DPQ020 >1
then depression = 1; /*Other depression*/
else if depressionscore <2 and DPQ010 >1 or DPQ020 > 1 then Depression =0;
/*no depression*/
Else if depressionscore >= 0 and DPQ010 <=1 and DPQ020 <=1 then Depression
=0;
end;

Depression1 = .;
```

```
if DPQ010 > 4 then DPQ010 = .;
if DPQ020 > 4 then DPQ020 = .;
if DPQ030 > 4 then DPQ030 = .;
if DPQ040 > 4 then DPQ040 = .;
if DPQ050 > 4 then DPQ050 = .;
if DPQ060 > 4 then DPQ060 = .;
if DPQ070 > 4 then DPQ070 = .;
if DPQ080 > 4 then DPQ080 = .;
if DPQ090 > 4 then DPQ090 = .;

Depressionscore1 = Sum
(DPQ010,DPQ020,DPQ030,DPQ040,DPQ050,DPQ060,DPQ070,DPQ080,DPQ090);

If depressionscore1 ^=. then do;
if depressionscore1 <= 9 then Depression1 = 0; /*none or mild*/
else if depressionscore1 >9 and Depressionscore1 <=14 then Depression1 = 1;
/*moderate*/
else if Depressionscore1 >14 then Depression1 =2; /*Moderately severe or
severe*/
end;


                /****** PHYSICAL FUNCTIONALITY ******/

*
PFQ054      Num   8               Need special equipment to walk
PFQ060B     Num   8               Walking for a quarter mile difficulty
PFQ060C     Num   8               Walking up ten steps difficulty
PFQ060D     Num   8               Stooping, crouching, kneeling difficulty
PFQ060E     Num   8               Lifting or carrying difficulty

PFQ060F     Num   8               House chore difficulty

PFQ060G     Num   8               Preparing meals difficulty
PFQ060H     Num   8               Walking between rooms on same floor
PFQ060I     Num   8               Standingup from armless chair difficulty

PFQ060J     Num   8               Getting in and out of bed difficulty
PFQ060K     Num   8               Using fork, knife, drinking from cup
PFQ060L     Num   8               Dressing yourself difficulty

PFQ061B     Num   8               Walking for a quarter mile difficulty
PFQ061C     Num   8               Walking up ten steps difficulty
PFQ061D     Num   8               Stooping, crouching, kneeling difficulty
PFQ061E     Num   8               Lifting or carrying difficulty

PFQ061F     Num   8               House chore difficulty

PFQ061G     Num   8               Preparing meals difficulty
PFQ061H     Num   8               Walking between rooms on same floor
PFQ061I     Num   8               Standingup from armless chair difficulty
PFQ061J     Num   8               Getting in and out of bed difficulty
PFQ061K     Num   8               Using fork, knife, drinking from cup
PFQ061L     Num   8               Dressing yourself difficulty
;
```

```
Functional = .;
ADL = .;

if PFQ054 > 2 then PFQ054 =.;

if PFQ060B > 4 then PFQ061B =.;
if PFQ060B = 4 then PFQ061B = 4;
if PFQ060B = 3 then PFQ061B = 3;
if PFQ060B = 2 then PFQ061B = 2;
if PFQ060B = 1 then PFQ061B = 1;
if PFQ060B = 0 then PFQ061B = 0;

if PFQ060c > 4 then PFQ061c =.;
if PFQ060c = 4 then PFQ061c = 4;
if PFQ060c = 3 then PFQ061c = 3;
if PFQ060c = 2 then PFQ061c = 2;
if PFQ060c = 1 then PFQ061c = 1;
if PFQ060c = 0 then PFQ061c = 0;


if PFQ060d > 4 then PFQ061d =.;
if PFQ060d = 4 then PFQ061d = 4;
if PFQ060d = 3 then PFQ061d = 3;
if PFQ060d = 2 then PFQ061d = 2;
if PFQ060d = 1 then PFQ061d = 1;
if PFQ060d = 0 then PFQ061d = 0;

if PFQ060e > 4 then PFQ061e =.;
if PFQ060e = 4 then PFQ061e = 4;
if PFQ060e = 3 then PFQ061e = 3;
if PFQ060e = 2 then PFQ061e = 2;
if PFQ060e = 1 then PFQ061e = 1;
if PFQ060e = 0 then PFQ061e = 0;


if PFQ060F > 4 then PFQ061F =.;
if PFQ060F = 4 then PFQ061F = 4;
if PFQ060F = 3 then PFQ061F = 3;
if PFQ060F = 2 then PFQ061F = 2;
if PFQ060F = 1 then PFQ061F = 1;
if PFQ060F = 0 then PFQ061F = 0;


if PFQ060h > 4 then PFQ061h =.;
if PFQ060h = 4 then PFQ061h = 4;
if PFQ060h = 3 then PFQ061h = 3;
if PFQ060h = 2 then PFQ061h = 2;
if PFQ060h = 1 then PFQ061h = 1;
if PFQ060h = 0 then PFQ061h = 0;

if PFQ060i > 4 then PFQ061i =.;
if PFQ060i = 4 then PFQ061i = 4;
if PFQ060i = 3 then PFQ061i = 3;
if PFQ060i = 2 then PFQ061i = 2;
if PFQ060i = 1 then PFQ061i = 1;
if PFQ060i = 0 then PFQ061i = 0;
```

```
if PFQ060j > 4 then PFQ061j =.;
if PFQ060j = 4 then PFQ061j = 4;
if PFQ060j = 3 then PFQ061j = 3;
if PFQ060j = 2 then PFQ061j = 2;
if PFQ060j = 1 then PFQ061j = 1;
if PFQ060j = 0 then PFQ061j = 0;

if PFQ060k > 4 then PFQ061k =.;
if PFQ060k = 4 then PFQ061k = 4;
if PFQ060k = 3 then PFQ061k = 3;
if PFQ060k = 2 then PFQ061k = 2;
if PFQ060k = 1 then PFQ061k = 1;
if PFQ060k = 0 then PFQ061k = 0;

if PFQ060l > 4 then PFQ061l =.;
if PFQ060l = 4 then PFQ061l = 4;
if PFQ060l = 3 then PFQ061l = 3;
if PFQ060l = 2 then PFQ061l = 2;
if PFQ060l = 1 then PFQ061l = 1;
if PFQ060l = 0 then PFQ061l = 0;


if PFQ061B  > 5 then PFQ061B =.;
if PFQ061B  = 5 then PFQ061B =4;

SPFQ061B = .;
if PFQ061B >=0 then SPFQ061B =1;

if PFQ061C > 5 then PFQ061c =.;
if PFQ061c  = 5 then PFQ061C =4;

SPFQ061c = .;
if PFQ061c >=0 then SPFQ061c =1;

if PFQ061D > 5 then PFQ061d =.;
if PFQ061D  = 5 then PFQ061D =4;

SPFQ061d = .;
if PFQ061d >=0 then SPFQ061d =1;

if PFQ061E > 5 then PFQ061e =.;
if PFQ061E  = 5 then PFQ061E =4;

SPFQ061e = .;
if PFQ061e >=0 then SPFQ061e =1;

if PFQ061F > 5 then PFQ061F =.;
if PFQ061F  = 5 then PFQ061F =4;

SPFQ061F = .;
if PFQ061F >=0 then SPFQ061F =1;

if PFQ061H > 5 then PFQ061h =.;
if PFQ061H  = 5 then PFQ061H =4;

SPFQ061h = .;
```

```
if PFQ061h >=0 then SPFQ061h =1;

if PFQ061I > 5 then PFQ061i =.;
if PFQ061I  = 5 then PFQ061I =4;

SPFQ061i = .;
if PFQ061i >=0 then SPFQ061i =1;

if PFQ061J > 5 then PFQ061j =.;
if PFQ061J  = 5 then PFQ061J =4;

SPFQ061j = .;
if PFQ061j >=0 then SPFQ061j =1;

if PFQ061K > 5 then PFQ061k =.;
if PFQ061K  = 5 then PFQ061K =4;

SPFQ061K = .;
if PFQ061k >=0 then SPFQ061k =1;

if PFQ061L > 5 then PFQ061l =.;
if PFQ061L  = 5 then PFQ061L =4;

SPFQ061l = .;
if PFQ061L >=0 then SPFQ061L =1;


FunctionScore = .;
Functionscore = Sum (SPFQ061B, SPFQ061c, SPFQ061d, SPFQ061e, SPFQ061h,
SPFQ061i);


if FunctionScore ^=. then do;

if PFQ054 = 2
AND PFQ061B >=1 and PFQ061B < 3
and PFQ061c >=1 AND PFQ061c <3
and PFQ061d >=1 AND PFQ061d <3
and PFQ061e >=1 AND PFQ061e <3
and PFQ061F >=1 AND PFQ061F <3
and PFQ061h >=1 AND PFQ061h <3
and PFQ061i >=1 AND PFQ061i <3
then FUNCTIONAL = 1;

else IF PFQ054 = 1
OR PFQ061B > 2
OR PFQ061c > 2
OR PFQ061d > 2
OR PFQ061e > 2
OR PFQ061F > 2
OR PFQ061h > 2
OR PFQ061i > 2
then FUNCTIONAL = 2;
end;

if FunctionScore < 4 then FUNCTIONAL = .;
```

```
ADLSCORE = .;
ADLSCORE = SUM (SPFQ061l, SPFQ061j, SPFQ061K);

if PFQ061j >= 1 and PFQ061j < 3 and PFQ061k >= 1 and PFQ061k < 3 and
PFQ061l >= 1 and PFQ061l < 3 then ADL = 1;
if PFQ061j > 2 OR PFQ061K > 2 OR PFQ061L > 2 then ADL = 2;
if ADLSCORE < 2 then ADL = .;



*SCREEN TIME

PAQ710                  Hours watch TV or videos past 30 days
PAQ715                  Hours use computer past 30 days
PAD600                  # of hours use computer past 30 days
PAD590                  # hours watch TV or videos past 30 days
;

Screentime = .;

if PAQ710 > 20 then PAD590 = .;
if PAQ715 > 20 then PAD600 = .;
if PAD590 > 20 then PAD590 = .;
if PAD600 > 20 then PAD600 = .;

if PAQ710 > 5 then PAD590 = 0; /*Tv time 2010-2016 0 hours*/
if PAQ710 = 0 then PAD590 = 0;

if PAQ710 = 1 then PAD590 = 1;
if PAQ710 = 2 then PAD590 = 2;
if PAQ710 = 3 then PAD590 = 3;
if PAQ710 = 4 then PAD590 = 4;
if PAQ710 = 5 then PAD590 = 5;

if PAQ715 > 5 then PAD600 = 0; /*computer time 2010-2016 0 hours*/
if PAQ715 = 0 then PAD600 = 0;

if PAQ715 = 1 then PAD600 = 1;
if PAQ715 = 2 then PAD600 = 2;
if PAQ715 = 3 then PAD600 = 3;
if PAQ715 = 4 then PAD600 = 4;
if PAQ715 = 5 then PAD600 = 5;

if PAD590 > 5 then PAD590 = 0;/*TV time 2001-2009 0 hours*/
if PAD600 > 5 then PAD600 = 0; /*computer time 2001-2009 0 hours*/
if PAQ480 = 6 then PAQ480 = 0; /*tv and computer 1999-2000*/
if PAQ480 > 7 then PAQ480 = .; /*tv and computer 1999-2000*/

Screentime = PAQ480;

screensum = .;

screensum = sum (PAD600, PAD590);
If screensum > 5 then screensum = 5;
if screensum = 0 then Screentime = 0;
if screensum = 1 then Screentime = 1;
if screensum = 2 then Screentime = 2;
```

```
if screensum = 3 then Screentime = 3;
if screensum = 4 then Screentime = 4;
if screensum = 5 then Screentime = 5;



/***** EOSS SCORING *****/


ArthiritsEOSS = .;

if Arthritis = 1 then ArthiritsEOSS = 2;
if Arthritis = 0 then ArthiritsEOSS = 0;

CHFeoss = .;

if CHF = 1 then CHFeoss = 3;
if CHF = 2 then CHFeoss = 0;

CADeoss = .;
*check if can be bumped to CATEOSS 2;

if CAD = 1 then CADeoss = 3;
if CAD = 2 then CADeoss = 0;

AnginaEOSS = .;

if Angina = 1 then AnginaEOSS = 3;
if Angina = 2 then AnginaEOSS = 0;

STEMIEOSS = .;

if STEMI = 1 then STEMIEOSS = 3;
if STEMI = 2 then STEMIEOSS = 0;

strokeEOSS = .;

if stroke = 1 then strokeEOSS = 3;
if stroke = 2 then strokeEOSS = 0;

GoutEOSS = .;

if Gout = 1 then GoutEOSS = 2;
if Gout = 0 then GoutEOSS = 0;


*FattyLiver EOSS score 2;


GluEOSS = .;

if GLUCAT = 0 then GluEOSS = 0;
if GLUCAT = 1 or GLUCAT = 2 then GluEOSS = 1;
if GLUCAT = 2 or DIQ070 = 1 then GluEOSS = 2;


HBPEOSS = .;
```

```
if sbp >0 and sbp <130 and dbp >0 or dbp <85 then HBPEOSS = 0;
if (sbp >= 130 and sbp <140) or (dbp >=85 and dbp < 90) then HBPEOSS =1;
if sbp >=140 or dbp >=90 or BPQ040A =1 or BPQ020 = 1 then HBPEOSS = 2;

if GluEOSS = 2 then do;

if sbp >0 and sbp <125 and dbp >0 and dbp <75 then HBPEOSS = 0;
if (sbp >= 125 and sbp <130) or (dbp >=75 and dbp < 80) then HBPEOSS =1;
if sbp >=130 or dbp >=80 or BPQ040A = 1 or BPQ020 =1 then HBPEOSS = 2;
end;


HDLeoss = .;

if SEX = 1 then do;
if HDL >= 1.6 then HDLeoss = 0;
if HDL >= 1 and HDL <1.6 then HDLeoss = 1;
if HDL < 1 then HDLeoss = 2;
end;

if SEX = 2 then do;
if HDL >= 1.6 then HDLeoss = 0;
if HDL >= 1.3 and HDL < 1.6 then HDLeoss = 1;
if HDL < 1.3 then HDLeoss = 2;
end;

LDLeoss = .;

if LDL < 3.4 then LDLeoss = 0;
if LDL >= 3.4 and LDL < 4 then LDLeoss = 1;
if LDL >= 4 then LDLeoss = 2;

TCHOLeoss = .;
* missing BPQ100D;

if CHOL < 5.2 then TCHOLeoss = 0;
if CHOL >= 5.2 and CHOL <6.2 then TCHOLeoss = 1;
if CHOL >= 6.2 or BPQ080 = 1 then TCHOLeoss = 2;

TGeoss=.;

if TG < 1.7 then TGeoss = 0;
if TG >= 1.7 and TG < 2.3 then TGeoss = 1;
if TG >= 2.3 then TGeoss = 2;


DepressionEOSS = .;

if Depression = 0 then DepressionEOSS = 0;
if Depression = 1 then DepressionEOSS =2;
if Depression = 2 then DepressionEOSS =3;

FunctionalEOSS = .;

if FUNCTIONAL = 1 and ADL = 1 then FunctionalEOSS = 0;
if FUNCTIONAL = 2 then FunctionalEOSS = 1;
```

```
if ADL = 2 then FunctionalEOSS = 3;  /* CHANGEED ADL TO EOSS 3 */

*currently not inc: EGFR, ast, alt;

Physicaleoss = .;

if ArthiritsEOSS = 0
or CHFeoss = 0
or CADeoss = 0
or AnginaEOSS = 0
or STEMIEOSS = 0
or strokeEOSS = 0
or GoutEOSS = 0
or GluEOSS = 0
or hbpEOSS = 0
or HDLeoss = 0
or LDLeoss = 0
or TCHOLeoss = 0
or TGeoss = 0
then Physicaleoss = 0;

if ArthiritsEOSS = 1
or CHFeoss = 1
or CADeoss = 1
or AnginaEOSS = 1
or STEMIEOSS = 1
or strokeEOSS = 1
or GoutEOSS = 1
or GluEOSS = 1
or hbpEOSS = 1
or HDLeoss = 1
or LDLeoss = 1
or TCHOLeoss = 1
or TGeoss = 1
then Physicaleoss = 1;

if ArthiritsEOSS = 2
or CHFeoss = 2
or CADeoss = 2
or AnginaEOSS = 2
or STEMIEOSS = 2
or strokeEOSS = 2
or GoutEOSS = 2
or GluEOSS = 2
or hbpEOSS = 2
or HDLeoss = 2
or LDLeoss = 2
or TCHOLeoss = 2
or TGeoss = 2
or FattyLiver = 1
then Physicaleoss = 2;

if ArthiritsEOSS = 3
or CHFeoss = 3
or CADeoss = 3
or AnginaEOSS = 3
or STEMIEOSS = 3
```

```
or strokeEOSS = 3
or GoutEOSS = 3
or GluEOSS = 3
or hbpEOSS = 3
or HDLeoss = 3
or LDLeoss = 3
or TCHOLeoss = 3
or TGeoss = 3
or COPD = 1
then Physicaleoss = 3;

TotalEOSS = .;
if functionaleoss =0 or physicaleoss=0 or depressioneoss = 0 then TotalEOSS =
0;
if functionaleoss =1 or physicaleoss=1 or depressioneoss = 1 then TotalEOSS =
1;
if functionaleoss =2 or physicaleoss=2 or depressioneoss = 2 then TotalEOSS =
2;
if functionaleoss =3 or physicaleoss=3 or depressioneoss = 3 then TotalEOSS =
3;
```