https://doi.org/10.47108/jidhealth.Vol9.Iss5.468
Grimwood S, et al., Journal of Ideas in Health (2026); 9(5):1501-1507
Journal of Ideas in Health

Sleep disturbance and fatigue among women with chronic obstructive pulmonary disease: socioeconomic and multi-morbidity influences in a nationally representative sample

Samuel Grimwood[1*], Joanna Dilks[2], Kisane Prutton[1]

Abstract

Background: This study examines the prevalence and social patterning of sleep disturbance and fatigue as item-level depressive symptoms among women with chronic obstructive pulmonary disease (COPD).

Methods: Data was drawn from 564 women aged 40-79 years (mean age = 62) with spirometry defined COPD in the 2007–2012 U.S. National Health and Nutrition Examination Survey. Logistic regression evaluated associations between age, race/ethnicity, socioeconomic position, smoking, lung function, multi-morbidity, and symptom outcomes. The adjusted regression analyses included 486 participants with complete data.

Results: Sleep disturbance was associated with younger age relative to the sample range (40–79 years) (OR = 0.98, 95% CI [0.96, 0.99]) and lower socioeconomic position (aOR = 2.04, 95% CI [1.25, 3.31]), p = .004). Fatigue was associated with younger age (OR = 0.96, 95% CI [0.95, 0.98]), p < .001), lower socioeconomic position (aOR = 2.31, 95% CI [1.40, 3.81], p = .001), and multi-morbidity (≥2 chronic conditions versus 0-1; aOR = 2.16, 95% CI [1.31, 3.58], p = .003). Race/ethnicity, smoking, and lung function were not independently associated with either outcome.

Conclusion: Findings suggest that socioeconomic disadvantage and multimorbidity may be important considerations when assessing fatigue and sleep disturbance among women with COPD, supporting a more intersectional approach to symptom assessment and pulmonary rehabilitation.

Keywords: COPD, Women's Health, Fatigue, Sleep Disturbance, Socioeconomic Status, NHANES, UK

Correspondence: Samuel Grimwood (Samuel.grimwood@googlemail.com)
[1]Independent Researcher, United Kingdom.

How to cite: Grimwood S, Dilks J, Prutton K. Sleep disturbance and fatigue among women with chronic obstructive pulmonary disease: socioeconomic and multi-morbidity influences in a nationally representative sample. J Ideas Health. 2026 October 31;9(5):1501-1507. doi: 10.47108/jidhealth.Vol9.Iss5.468

Article Info: (**Original Research**)
Received: 24 September 2026
Revised: 30 September 2026
Accepted: 16 October 2026
Published: 31 October 2026

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Journal Home Page: https://www.jidhealth.com
e ISSN: 2645-9248

Background

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity worldwide [1] and is increasingly recognised as a condition with substantial psychological, social, and functional consequences [2]. Although COPD was historically characterised as a predominantly male disease, its burden among women has increased, and evidence suggests that women may experience differences in clinical presentation, symptom burden, and health-related quality of life [3,4]. Fatigue and sleep disturbance are particularly problematic for women with COPD, given their associations with impaired quality of life, psychological wellbeing, and daily functioning [5,6]. These symptoms may also interact with the broader social and practical demands of daily life, potentially compounding the challenges of living with a chronic respiratory condition. However, the extent to which gendered social roles contribute to symptom burden remains insufficiently understood. Fatigue is one of the most commonly endorsed and debilitating symptoms in COPD, often described as more limiting than breathlessness itself [7]. Sleep disturbance, including difficulty initiating or maintaining sleep, is also highly prevalent and associated with poorer physical functioning, mood disturbance, and increased healthcare utilisation [8]. Sleep disturbance has been shown to predict healthcare utilisation in COPD [9], and fatigue independently contributes to impaired quality of life [10]. Despite their impact, these symptoms remain under-recognised in routine respiratory care. Emerging evidence suggests that symptom patterns may differ between women and men with COPD, with sleep disturbance, fatigue and mood symptoms potentially clustering more prominently among women [11]. This highlights the importance of examining these symptoms specifically among women rather than assuming that findings from mixed-sex populations apply equally across groups. At the same time, symptom experience and disease burden in COPD are shaped not

only by gender but also by intersecting social determinants of health. Socioeconomic disadvantage is consistently associated with higher COPD prevalence, greater multimorbidity, more severe symptoms, and increased economic burden [12]. Socioeconomic disadvantage may influence symptom burden through environmental exposures, barriers to healthcare and reduced availability of supportive resources [13, 14]. Examining socioeconomic position alongside clinical indicators may therefore provide a broader understanding of sleep disturbance and fatigue among women with COPD. Women's experiences of chronic illness may also be influenced by caregiving responsibilities, employment demands and cumulative socioeconomic pressures across the life course [15]. These contextual factors may interact with clinical disease burden, reinforcing the importance of considering social and demographic characteristics when examining symptoms among women with COPD. Age-related biological and psychosocial changes may also influence symptom experience among women. The menopausal transition has been associated with changes in sleep quality and respiratory health [16, 17]. However, the contribution of menopause to sleep disturbance and fatigue among women with COPD remains poorly understood, particularly in methodologies that decontextualise symptoms from socioeconomic factors. To date, population-level quantitative research focusing specifically on fatigue and sleep disturbance among women with COPD remains limited. Many large-scale studies aggregate men and women or prioritise physiological indices, potentially obscuring gender-specific and intersectional patterns. Examining these symptoms in relation to intersectionality of socioeconomic position, race/ethnicity, age and multimorbidity may help identify factors associated with symptom burden beyond measured airflow limitation. The present study therefore aimed to examine sociodemographic and clinical correlates of sleep disturbance and fatigue among women with spirometry-defined COPD using nationally representative data. We hypothesised that younger age, lower socioeconomic position, and multimorbidity would be associated with higher odds of sleep disturbance and fatigue, independent of lung function and smoking status.

Aims of study

The primary objective of this study was to investigate the relationships between race/ethnicity, socioeconomic position, and specific depressive symptom components—namely sleep disturbance and fatigue, among women with spirometry-confirmed COPD. A secondary objective was to determine whether these symptom domains were linked to greater overall disease burden, operationalised through the presence of multimorbidity.

Research objectives

The objectives were to estimate the prevalence of sleep disturbance and fatigue among men with COPD; to examine differences in these symptoms across racial/ethnic and socioeconomic groups; to assess associations between sleep disturbance, fatigue, and indicators of disease burden; and to determine whether these associations persist after adjustment for lung function severity and smoking status.

Research Questions

(1) Quantify the prevalence of sleep disturbance and fatigue among women with COPD
(2) Evaluate differences in these symptoms across racial/ethnic and income groups
(3) Examine associations between sleep disturbance, fatigue, and markers of disease burden
(4) Assess whether observed relationships remained statistically significant after accounting for lung function severity and smoking behaviour.

Hypotheses

It was hypothesised that sleep disturbance and fatigue would be common among women with COPD and more frequently reported among those from racially/ethnically minoritised groups and lower-income backgrounds. Lower socioeconomic position was expected to demonstrate an independent association with both symptom outcomes. Additionally, sleep disturbance and fatigue were anticipated to correlate with greater multimorbidity, and these relationships were expected to remain significant after controlling for lung function impairment and smoking status.

Methods

Study Design

A cross-sectional secondary analysis was conducted using data from the U.S. National Health and Nutrition Examination Survey (NHANES). Data from three survey cycles were combined to increase the available sample size. Specifically, data from the 2007–2008, 2009–2010, and 2011–2012 cycles were utilised, as these were the most recent cycles that included both spirometry measurements and item-level depressive symptom data from the Patient Health Questionnaire-9 (PHQ-9). Subsequent NHANES cycles did not contain directly comparable spirometry assessments, limiting their appropriateness for COPD classification. Combining the selected cycles increased the number of eligible participants available for analysis. Because the study focused on cross-sectional symptom associations rather than temporal change, restricting analyses to these cycles was methodologically justified.

Participants

COPD status was determined using spirometry data obtained during NHANES mobile examination centre assessments. In line with Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria, airflow obstruction was defined as a pre-bronchodilator FEV_1/FVC ratio below 0.70. Across the 2007–2012 NHANES cycles, 20,176 participants had spirometry records, of whom 1,887 met the study's pre-bronchodilator airflow obstruction criterion ($FEV_1/FVC < 0.70$). The study sample comprised 564 women aged 40–79 years who met the spirometric definition of COPD. Valid responses to each PHQ-9 symptom outcome were available for 533 women, while 486 participants had complete data for the multivariable regression analyses. The age threshold of ≥40 years was selected to reflect the typical adult-onset presentation of COPD observed in clinical practice [14].

Recruitment and Accessibility

NHANES employs a complex, multistage probability sampling framework designed to generate a nationally representative sample of the non-institutionalised U.S. population. Data

collection includes structured household interviews and standardised examinations conducted in mobile examination centres.

Measures

Demographic Variables

Age was recorded continuously in years. Race/ethnicity was self-reported and classified as Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black, or other race/multiracial. Socioeconomic position was measured using the poverty–income ratio (PIR), defined as the ratio of family income to the federal poverty threshold. PIR was classified into four categories: PIR < 1.0 (category 0, below the poverty line), PIR 1.0 to < 2.0 (category 1), PIR 2.0 to < 3.0 (category 2), and PIR ≥ 3.0 (category 3, higher income). PIR is commonly used in NHANES research as an indicator of economic resources. Educational attainment was not included in the primary analyses.

Clinical Variables

COPD was defined using spirometry data collected during the NHANES mobile examination centre assessments. Participants with a pre-bronchodilator forced expiratory volume in one second to forced vital capacity ratio (FEV_1/FVC) below 0.70 were classified as having COPD. The FEV_1/FVC ratio was also included as a continuous variable in the regression analyses; formal COPD severity grades were not assigned. Smoking status was categorised as never smoked, former smoker, or current smoker based on self-reported questionnaire responses. Multimorbidity was defined as the presence of two or more physician-diagnosed chronic conditions (e.g., cardiovascular disease, diabetes, arthritis, cancer), consistent with established epidemiological conventions. These conditions were identified via self-report. Menopausal status was considered for analyses but excluded due to substantial missing data.

Primary Outcomes

Sleep disturbance and fatigue were assessed using individual items from the Patient Health Questionnaire-9 (PHQ-9). Item 3 assessed sleep-related difficulties ("Trouble falling or staying asleep, or sleeping too much"), while Item 4 assessed fatigue ("Feeling tired or having little energy"). The original item responses were dichotomised by the authors for the present analysis, with responses of 0 ("not at all") coded as absence of the symptom and responses of ≥1 ("several days" or more) coded as symptom presence. This approach was adopted to identify any reported occurrence of each symptom during the preceding two weeks, rather than to quantify symptom frequency or severity. These outcomes represent the presence of self-reported symptoms and should not be interpreted as clinical diagnoses of sleep disorders or fatigue-related conditions.

Procedure

NHANES data files were obtained from the Centers for Disease Control and Prevention (CDC) website. Data from the selected cycles (2007–2012) were combined and merged using the unique participant identifier (SEQN). The dataset was cleaned and restricted to eligible women aged 40–79 years with spirometry-defined COPD. The initial sample comprised 564 women, of whom 486 were included in complete-case regression analyses; 78 participants (13.8%) were excluded from these models because of missing information in one or more variables.

Quantitative Analysis

Descriptive analyses were conducted to characterise the sample and estimate the prevalence of sleep disturbance and fatigue. Multivariable logistic regression models were used to evaluate associations between race/ethnicity, socioeconomic position, and each symptom outcome, adjusting for age, lung function, smoking status, and multimorbidity. Logistic regression was selected due to the binary nature of the PHQ-9 symptom variables and the need to control for multiple covariates simultaneously. All analyses were performed using SPSS. Conventional binary logistic regression was conducted without incorporating NHANES survey weights, strata or primary sampling units. Consequently, the descriptive statistics and regression estimates reflect unweighted analyses of the study sample.

Sample Size and Statistical Precision

As this was a secondary analysis of existing NHANES data, the sample size was determined by the number of participants meeting the eligibility criteria rather than by prospective recruitment. No a priori power calculation was performed. The regression models included 486 complete cases, and the precision of the resulting estimates was considered using their 95% confidence intervals. For an unweighted sample of 533 independent observations and an assumed symptom prevalence of 50%, the approximate conventional 95% confidence interval margin of error was ±4.2 percentage points; this illustrative calculation did not account for the complex NHANES sampling design.

Results

Sample characteristics

The analytic sample comprised 564 women with spirometry-defined COPD. Participants had a mean age of 62 years (SD = 10.71) and a mean FEV_1/FVC ratio of 0.63 (SD = 0.07). Sleep disturbance was reported by 50% of participants, while 53% reported fatigue. Approximately one-fifth of the sample (21%) reported two or more comorbid conditions. Sample characteristics are presented in Table 1. The adjusted logistic regression analyses included 486 participants with complete data; 78 participants were excluded because of missing information. Consistent with the study hypotheses, adjusted regression analyses indicated that socioeconomic position was significantly associated with both sleep disturbance and fatigue. Women in the lowest income category had approximately twice the odds of reporting sleep disturbance and fatigue compared to those in the highest income category. Younger age was also associated with higher odds of both symptoms. In contrast, lung function, race/ethnicity, and smoking status were not independently associated with either outcome. Multimorbidity was significantly associated with fatigue but not sleep disturbance. These findings highlight socioeconomic disadvantage and younger age as correlates of both symptoms, with multimorbidity additionally associated with fatigue, among women with COPD.

Table 1. Sociodemographic and clinical characteristics of women with spirometry-defined COPD.

Variable	**N**	**Mean**	**SD**	**Range**
Age (years)	564	62	10.71	40–79
FEV_1/FVC ratio	564	0.63	0.07	0.32–0.70
Categorical variables			**N**	**%**
Race/ethnicity				
Mexican American			31	6
Other Hispanic			38	7
Non-Hispanic White			352	62
Non-Hispanic Black			107	19
Other race / multi-racial			36	6
Poverty–income ratio (PIR)				
Category 0 (lowest income)			165	29
Category 1			79	14
Category 2			81	14
Category 3 (highest income)			188	33
Smoking status				
Never smoked			207	37
Former smoker			172	31
Current smoker			185	33
Sleep disturbance			268	50
Fatigue			284	53
≥2 comorbid conditions			118	21

Note. Percentages may not total 100 due to rounding or missing data. COPD was defined as FEV_1/FVC < 0.70. PIR Category 0 represents income below the poverty threshold; Categories 1 and 2 represent low income above the poverty line; Category 3 represents higher income.

Table 2. Adjusted logistic regression model predicting sleep disturbance among women with COPD

Predictor	OR	95% CI	p
Age (per year)	0.98	[0.96, 0.99]	0.029
FEV_1/FVC	0.31	[0.018, 5.612]	0.431
Poverty–income ratio (PIR) (overall)	---	---	0.033
Category 3 (highest income)	Reference	---	---
Category 0 vs. Category 3	2.04	[1.25, 3.31]	.004
Category 1 vs 3	1.60	[0.92, 2.80]	0.094
Category 2 vs 3	1.29	[0.74, 2.25]	0.353
Race/ethnicity (overall)	—	—	0.799
Mexican American	Reference	—	—
Other Hispanic vs Mexican American	0.534	[0.18, 1.58]	.259
Non-Hispanic White vs Mexican American	0.823	[0.34, 1.97]	0.663
Non-Hispanic Black vs Mexican American	0.743	[0.29, 1.87]	0.531
Other race/multiracial vs Mexican American	0.737	[0.23, 2.34]	0.605
Smoking status (overall)	—	—	0.077
Current smoker	Reference	—	—
Never smoker vs current	0.951	[0.58, 1.53]	0.836
Former smoker vs current	1.566	[0.96, 2.54]	0.070
Multimorbidity	—	—	—
0–1 chronic conditions	Reference	—	—
≥2 chronic conditions vs 0–1	1.389	[0.86, 2.23]	0.177

Note. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) are from complete-case logistic regression (N = 486; 78 of 564 participants excluded due to missing data). Overall p-values for PIR, race/ethnicity and smoking status are omnibus Wald tests; remaining p-values are for individual coefficients. Reference categories are shown explicitly.

Table 3. Adjusted logistic regression model predicting fatigue among women with COPD

Predictor	OR	95% CI	p
Age (per year)	0.96	[0.91, 0.98]	<0.001
FEV_1/FVC	0.19	[0.009, 3.897]	0.282
Poverty–income ratio (PIR) (overall)	—	—	0.011
Category 3 (highest income)	Reference	—	—
Category 0 vs 3	2.31	[1.40, 3.81]	0.001
Category 1 vs 3	1.39	[0.79, 2.45]	0.248
Category 2 vs 3	1.20	[0.68, 2.09]	0.522
Race/ethnicity (overall)	—	—	0.464
Mexican American	Reference	—	—
Other Hispanic vs Mexican American	0.77	[0.25, 2.32]	0.646
Non-Hispanic White vs Mexican American	1.35	[0.55, 3.28]	0.504
Non-Hispanic Black vs Mexican American	1.01	[0.39, 2.59]	0.974
Other race/multiracial vs Mexican American	1.80	[0.56, 5.82]	0.323
Smoking status (overall)	—	—	0.251
Current smoker	Reference	—	—
Never smoker vs current	0.73	[0.45, 1.20]	0.225
Former smoker vs current	1.08	[0.66, 1.78]	0.746
Multimorbidity	—	—	—
0–1 chronic condition	Reference	—	—
≥2 chronic conditions vs 0–1	2.16	[1.31, 3.58]	0.003

Note. Adjusted odds ratios (aORs) and 95% confidence intervals (CIs) are from complete-case logistic regression (N = 486; 78 of 564 participants excluded due to missing data). Overall p-values for PIR, race/ethnicity and smoking status are omnibus Wald tests; remaining p-values are for individual coefficients. Reference categories are shown explicitly.

Sleep disturbance

Sleep disturbance demonstrated a selective pattern of association (see Table 2). Younger age (relative to the sample of participants between 40-79) was independently associated with higher odds of reporting sleep problems (aOR = 0.98, 95% CI [0.96, 0.99], p = .029). Socioeconomic position was also significantly associated with sleep disturbance overall (p = .033), with women in the lowest income category exhibiting approximately twice the odds of sleep problems compared with those in the highest income group (aOR = 2.04, 95% CI [1.25, 3.31], p = 0.004). Race/ethnicity, smoking status, lung function (FEV_1/FVC), and multimorbidity were not independently associated with sleep disturbance after adjustment for covariates.

Fatigue

Fatigue demonstrated a broader pattern of association (see Table 3). Younger age (relative to the sample of participants between 40-79) was associated with higher odds of fatigue (aOR = 0.96, 95% CI [0.95, 0.98], p < .001). Socioeconomic position was significantly associated with fatigue overall (p = .011), with women in the lowest income group showing more than twice the odds of reporting fatigue compared with those in the highest income category (OR = 2.31, 95% CI [1.40, 3.81], p = .001). Multimorbidity was also independently associated with fatigue, with women reporting two or more chronic conditions showing significantly higher odds of fatigue, compared with those reporting zero or one chronic condition (aOR = 2.16, 95% CI [1.31, 3.58], p = .003). In contrast, race/ethnicity, smoking status, and lung function were not significantly associated with fatigue in adjusted models.

Discussion

This study examined sociodemographic and clinical correlates of sleep disturbance and fatigue among women with spirometry-defined COPD using nationally representative data. Two key findings emerged. First, fatigue and sleep disturbance were highly prevalent, affecting approximately half of women in the sample. Second, younger age and lower socioeconomic position were significantly associated with both outcomes, whereas lung function and smoking status were not independently associated after adjustment. Multimorbidity also emerged as a key correlate of fatigue. These findings suggest that social and clinical factors beyond measured lung function may be relevant to sleep disturbance and fatigue among women with COPD. Previous research has identified sex-related differences in symptom burden and symptom clustering among individuals with COPD, including differences involving sleep disturbance and fatigue [11]. Research has also suggested that younger women with COPD may experience a greater overall symptom burden than men of similar ages [18]. In the present female sample, younger age and socioeconomic disadvantage were associated with both sleep disturbance and fatigue, while multimorbidity was additionally associated with fatigue. These findings suggest that socioeconomic circumstances warrant consideration when assessing symptom burden among women with COPD. However, formal sex-interaction analyses would be required to establish whether these associations differ significantly between women and men. Women in the lowest income category had approximately twice the odds of reporting both symptoms compared with those in the highest income group. This association may reflect broader socioeconomic disadvantages, including cumulative financial strain, barriers to managing

chronic conditions, and reduced access to social support. Previous research has linked financial strain to poorer health among women, while studies of socioeconomically disadvantaged populations have identified financial constraints, competing priorities, and limited support networks as barriers to chronic disease self-management [19-21]. These factors represent plausible explanations for the observed association, although they were not directly assessed in the present study. The association between younger age and greater symptom burden warrants further investigation. Menopausal transition and associated hormonal changes have been linked to sleep disturbance in the wider literature [22]. However, menopausal status and hormone levels were not assessed in the present study, and the observed age associations cannot be attributed to hormonal mechanisms. Future research incorporating menopausal stage and relevant psychosocial factors may help clarify these relationships. The findings have potential implications for sex and gender related symptom assessment and pulmonary rehabilitation (PR). Routine assessment of sleep disturbance and fatigue may help identify needs that are not fully reflected by spirometry measures. Where appropriate, assessment could include validated instruments for sleep and fatigue, alongside consideration of multimorbidity and socioeconomic barriers to care. Flexible scheduling, transport support and access to psychosocial services may be relevant for women. However, the effectiveness of a gendered approach was not evaluated in the present study, and further research is needed to determine whether tailored PR interventions improve patient outcomes.

Limitations and Future Directions

Several limitations should be acknowledged. First, the study draws on US data, which may limit the generalisability of the findings to other populations. The cross-sectional design precludes causal inference, and symptom measures were based on self-report. The absence of direct measures of relevant biological and social factors, including menopausal stage, hormone therapy use, anxiety symptoms, and caregiving responsibilities, also limits our ability to examine their independent associations with sleep disturbance and fatigue. Future studies incorporating these measures could help clarify the contribution of life-course exposures to symptom disparities. Additionally, sleep disturbance was assessed using self-report and did not distinguish between insomnia, sleep-disordered breathing, and other sleep disorders. Future research should incorporate more detailed assessments of sleep to better characterise these symptoms. Individual-level PHQ-9 items were a further limitation, omitting symptom-specific sleep and fatigue measures. The precision of estimates should also be considered, particularly for less common predictor categories. Furthermore, the analyses did not account for the complex NHANES sampling design. Consequently, the estimates cannot be interpreted as nationally representative population estimates, and the reported confidence intervals and statistical significance should be interpreted cautiously. Future longitudinal studies using validated symptom measures and more comprehensive clinical and psychosocial assessments are needed.

Conclusion

Sleep disturbance and fatigue were common among women with spirometry-defined COPD. Younger age and socioeconomic disadvantage were associated with both symptoms, while multimorbidity was additionally associated with fatigue. These findings highlight the importance of taking an intersectional approach, considering sex- and gender-related socio-economic circumstances and coexisting chronic conditions alongside respiratory function when assessing symptom burden among women with COPD. Further longitudinal research is needed to clarify the mechanisms underlying these associations and evaluate whether tailored symptom assessment and rehabilitation approaches improve outcomes for women with COPD.

Abbreviation

CDC – Centers for Disease Control and Prevention
CI – Confidence Interval
COPD – Chronic Obstructive Pulmonary Disease
FACIT-F – Functional Assessment of Chronic Illness Therapy–Fatigue
FEV_1 – Forced Expiratory Volume in One Second
FVC – Forced Vital Capacity
FEV_1/FVC – Forced Expiratory Volume in One Second to Forced Vital Capacity Ratio
GAD-7 – Generalized Anxiety Disorder-7
GOLD – Global Initiative for Chronic Obstructive Lung Disease
ISI – Insomnia Severity Index
NHANES – National Health and Nutrition Examination Survey
OR – Odds Ratio
PHQ-9 – Patient Health Questionnaire-9
PIR – Poverty–Income Ratio
PR – Pulmonary Rehabilitation
SD – Standard Deviation
SEQN – Respondent Sequence Number
SPSS – Statistical Package for the Social Sciences
US – United States

Declaration

Acknowledgment

None.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Availability of data and materials

The data can be accessed on the NHANES website ttps://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2007.

Authors' contributions

Samuel Grimwood (SG) – Conceptualisation, Methodology, Data curation, Formal analysis, Investigation, Visualization, Writing – original draft, Writing – review & editing, Project administration. Joanna Dilks (JD) – Conceptualisation, Methodology, Writing – review & editing. Kisane Prutton (KP) – Conceptualisation, Methodology, Writing – review & editing. All authors read and approved the final manuscript.

Ethics approval and consent to participate

We conducted the research in accordance with the Declaration of Helsinki. Not Applicable, as the data has come from NHANES which is publicly available and ethics has been obtained.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interests.

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Author Details

[1]Indepemndent researcher, United Kingdom.

[2]Department The University of Nottingham and Lincolnshire Partnership NHS FT, United Kingdom.

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