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Relationships between body mass index and sleep quality and duration in adults 70 years and older☆

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ABSTRACT

Objective: Associations between sleep and body mass index (BMI) are age dependent. In older adults, BMI norms representing "normal" and "overweight" combine into a single "normal-weight" category. We aimed to assess the nonlinear associations between age-appropriate BMI categories and sleep duration (SD) and sleep efficiency (SE) in older men and women, controlling for health and functional status.

Methods: Secondary data analysis of the Hospitalization Process Effects on Functional Outcomes and Recovery included 719 community-dwelling adults age 70+ years hospitalized because of nondisabling diagnoses. Self-report intake data regarding their condition prior to circumstances that led to hospitalization were used to obtain BMI categories (underweight: BMI ≤ 23, normal weight: 23 < BMI < 30, and obese: BMI ≥ 30), SD, SE, health, and functional status. Analysis of covariance was used for modeling SD and SE separately, additively entering (1) BMI, (2) sex and BMI × sex, and (3) health and functional confounders.

Results: For SD and SE, significant BMI group differences in the first model ($P < .001$) remained significant in the second ($P < .001$) and third ($P < .01$) models. High BMI was associated with shorter SD and lower SE compared with normal- and low-BMI groups. Controlling for sex, an inverted *J*-shaped relationship appeared in women, whereby low- and, more prominently, high-BMI categories were associated with shorter SD and lower SE compared with normal BMI. Although associations remained consistent in the fully adjusted models, effect sizes were small.

Conclusions: Findings provide insights into possible mechanisms underlying BMI, sleep, and health and may contribute to informed clinical recommendations, particularly for older women.

Introduction

Associations between metabolic status and both duration and quality of sleep have been investigated extensively in cross-sectional and longitudinal studies in the general adult population.[1–9] Recent studies suggest that relationships between body mass index (BMI) and sleep duration (SD) are age dependent.[3,10] Based on objective (actigraphy) measurement, adults <50 years old showed a negative linear relationship between SD and BMI, whereas adults >50 years old demonstrated a *U*-shaped relationship, with short (<5 hours) and long (>8 hours) sleep associated with increased BMI.[3] These age differences were confirmed and expanded in an analysis from the National Health and Nutrition Examination Survey demonstrating a negative linear relationship in young adults, a *U*-shaped relationship in middle-aged adults, and an overall weaker relationship in older adults.[10]

Yet few studies have focused on the associations between sleep and metabolic indices in older adult populations.[11,12] Based on objective (actigraphy) measurements, short sleep (<5 hours) was associated with increased risks of about 4- and 2-fold for obesity in older men and women respectively, compared with 7 to 8 hours.[12] Findings from a prospective population-based study showed increased rates of obesity and severe obesity in older adults reporting ≤5 hours and 8 hours compared with 7 hours of sleep.[11] In the 2-year follow-up, ≤5 hours and 8-9 hours of sleep were both associated with increased weight gain compared with 7 hours in women only.

No studies to date have investigated the associations between categorical BMI norms and habitual sleep outcomes in older adults. Such an investigation is particularly relevant given that overweight in older adults does not constitute a major risk factor for morbidity

☆ Conflicts of interest: none.

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and may be protective for mortality,[14] thereby suggesting that BMI categories (ie, underweight, normal weight, overweight, and obesity) in young adults may be inaccurate for the older adult population.

Metabolic and sleep disturbances are associated with serious health and functional outcomes.[14,15] Thus, in addition to controlling for demographic (eg, age and sex) and risk behaviors or lifestyle factors,[6] studies have adjusted for health conditions such as hypertension,[5,7,16] heart problems and diabetes,[5,7,12] and depression.[8,11,12,16] Additional adjustments include self-perceived health,[4,11] number of chronic illnesses,[11] and physical activity.[5,12,16] It is evident that functional indices such as cognitive and functional status were not assessed in these investigations. Given that both morbidities and functional decline accumulate with age, simultaneous adjustment for these factors is particularly relevant in older adults.

The current study focused on the relationships between BMI categories and SD and sleep efficiency (SE) in adults 70 years and older, controlling for age, sex, comorbidities, and functional and cognitive status. We hypothesized that low- and high-BMI categories are related to short SD and to low SE and that these associations are maintained when controlling for comorbidity and functional indices.

Method

Design and study population

This study is a secondary data analysis of a prospective follow-up study: Hospitalization Process Effects on Functional Outcomes and Recovery. The original study followed a cohort of community-dwelling adults 70 years and older who were hospitalized because of nondisabling primary diagnoses in internal medical units of 2 hospitals in Northern Israel. Patients admitted for conditions such as stroke, coma, or mechanical ventilation were not included in the study. Data were collected during the period 2009-2011. Full eligibility criteria are described elsewhere.[17] In the current inquiry, we used intake data collected within the first 48 hours of admission, relying on patients' self-report regarding their condition prior to experiencing symptoms of acute illness or exacerbation of their chronic condition that led to hospitalization. The study was approved by the Institutional Reviews Boards (Helsinki committees) of each of the hospitals, Clalit Health Services, and the Israeli Ministry of Health. All participants in the study signed an informed consent form.

Of the 1042 participants enrolled at baseline, we excluded those who died during hospitalization (n = 14), those with low cognitive status (n = 176), and those with missing data on main study variables (n = 123). In addition, we excluded 10 participants who reported less than 2 hours of sleep per night. Thus, a total of 719 participants were included in the present analysis. See flowchart of the sample selection (Fig. 1).

Study measures

Sleep was assessed using the following items during baseline intake. Participants were asked to reflect on their habitual sleep patterns prior to the last 2 weeks leading up to the current hospitalization. SD was based on the item "How many hours do you sleep per night?"; SE was computed based on the ratio of SD to time in bed, calculated as the number of hours between bed and rise times, based on the items "At what time do you usually go to bed?" and "At what time do you usually get out of bed?"

Body mass index was calculated based on self-report of height and weight and confirmed partially by medical records. Based on well-established modified BMI thresholds for the older adult population,[18] participants were divided into 3 groups: underweight (BMI ≤ 23), normal and overweight (23 < BMI < 30) and obese (BMI ≥ 30).

Cognitive assessment was conducted using the Short Portable Mental Status Questionnaire (SPMSQ)[19] (score range, 0-10); participants scoring 5 or less required the involvement of a surrogate and were not included in the current study. Mental status was assessed based on self-report of depressive symptoms using the 10-item Tucker's Short Zung Instrument.[20] Functional status was measured as level of self-reported independence in performing basic activities of daily living (ADLs)[21] using the modified Barthel Index (BI).[22]

Comorbidities and diabetes diagnosis were retrieved from electronic medical records. Severity of chronic conditions was calculated using the Charlson Comorbidity Index weighing 20 health conditions based on severity level (total score range, 0-33).[23] Information on other covariates such as age, sex, family status, and sleep medication consumption was collected via personal interview at time of hospital admission.

Statistical analysis

SD and SE were used as continuous scores, and BMI was categorized as low (underweight), normal (including normal and overweight), and high (obese). Means and standard deviations were used to describe continuous variables, and percentages were used to summarize categorical variables. All study variables were presented for the total sample as well as for the 3 BMI groups. Group differences were compared using univariate analyses of

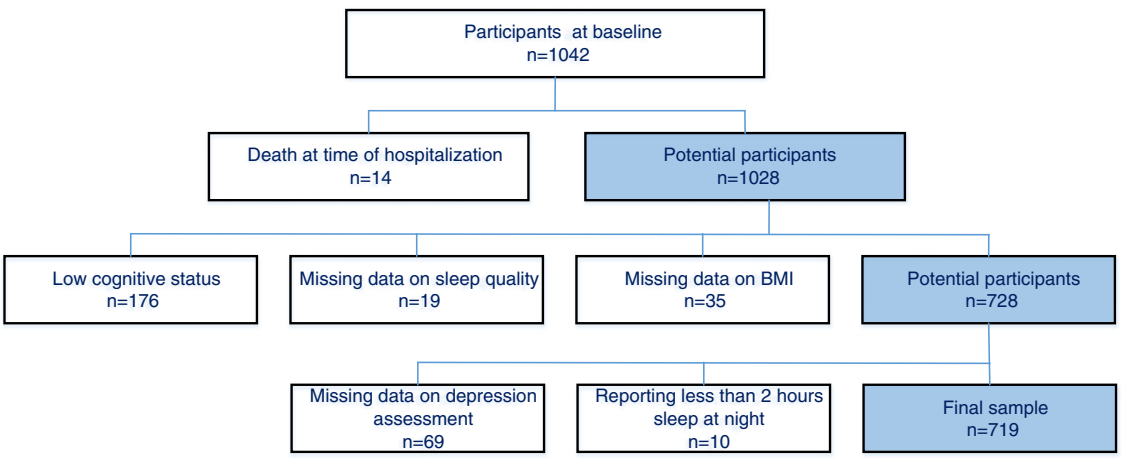

Fig. 1. Study sample inclusion criteria.