The Relationship between BMI, Sleep Quality, and Cognitive Performance among Overweight Adults

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Background

Human beings spend roughly a third of their lives asleep, highlighting the importance of sleep on optimal physical and cognitive functioning. Among western nations, sleep quality has drastically declined due to an increase in work demands (Cappuccio & Miller, 2017). While existing research has found a clear relationship between poor sleep and reduced long-term memory consolidation (Heyde et al., 2018), reported findings across other specific cognitive domains have been mixed at best. Thus, this study aims to explore the main effect of sleep quality on cognitive performance across five cognitive domains – attention/working memory, processing speed, executive function, and learning/memory.

Existing literature has also indicated that chronic sleep deprivation and high body mass index (BMI) may interact in a bidirectional manner and carry resembling physical and cognitive consequences (Cizza, Requena, Galli, & de Jonge, 2011). Obesity has been shown to reduce sleep duration, increase daytime sleepiness, and lower sleep efficiency (Ohayon & Vecchierini, 2005). Moreover, various epidemiological studies have strongly suggested that reduced sleep duration may be a potential risk factor for obesity, thus illustrating the bidirectional nature of this relationship (Morselli, Leproult, Balbo, & Spiegel, 2010).

Given existing research suggesting the interaction between obesity-level, BMI and poor sleep, it is unclear whether whether high BMI may modify the relationship between poor sleep quality and reduced cognitive performance. This study serves to 1) examine the independent main effects of sleep quality and BMI on cognitive performance, and 2) if a significant effect exists, examine the moderating effects of BMI on the relationship between sleep quality and cognitive performance.

Methods

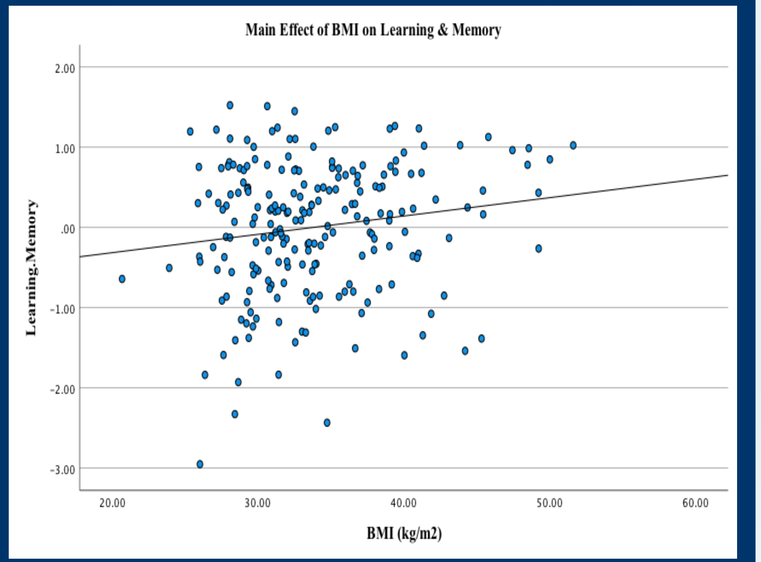
Adults between the ages of 25-84 were recruited for the Habitual diet and Avocado Trial (HAT) at Loma Linda University as part of an ancillary study exploring the effects of daily avocado intake on cognitive function. Participants were males and females who had an enlarged waist circumference (NCEP ATP III 2005: ≥35 inches F, ≥40 inches M). Exclusion criteria included any self-reported history of congestive heart failure and/or unstable medical conditions, current/recently quit smokers, a 10lb net gain/loss in the last year, current use of anti-psychotic medication, any dose change in anxiolytic and/or anti-depressant medication within the last six months. Eligible participants completed a two-hour neurocognitive battery, which included an assessment of attention/working memory (WAIS-IV Digit Span, Auditory Consonant Trigrams), processing speed (Trail Making Test A, Stroop A & B, Symbol Digit Modalities Test), executive function (FAS/Animals, Trail Making Test B, Stroop C), and learning/memory (Rey Auditory Verbal Learning Test, Brief Visuospatial Memory Test). Height (cm) and weight (kg) were measured at the time of assessment; Participants completed the Pittsbrugh Sleep Quality Index (PSQI), a self-report sleep scale, at the time of the assessment. A hierarchical regression analysis was performed to examine the effects of BMI and sleep quality on cognitive performance, while controlling for age, sex, and education. Analyses were run using SPSS version 26.0 software.

Table 1: Participant demographics.

Variable	Total Sample (n = 217) M (SD)
Sex, Male (n, %)	68 (31.3%)
Age, Years	49.61 (13.13)
Education, Years	14.66 (2.44)
BMI, kg/m²	33.87 (5.48)
PSQI_Total	5.80 (3.50)
Digit Span Total	26.81 (5.46)
Trail Making Test A	25.43 (2.11)
Trail Making Test B	65.41 (29.13)
Symbol Digit Modalities Test	48.17 (10.16)
FAS	9.30 (3.24)
Animals	21.38 (4.92)

Variable	Total Sample (n = 217) M (SD)
Stroop Color	71.78 (14.12)
Stroop Word	98.39 (17.27)
Stroop Color-Word	40.53 (10.51)
Auditory Consonant Trigrams	30.51 (8.61)
RAVLT_Immediate Recall	47.38 (9.82)
RAVLT_Short Delayed Recall	9.73 (3.11)
RAVLT_Long Delayed Recall	9.29 (3.24)
BVMT_Immediate Recall	25.32 (6.03)
BVMT_Delayed Recall	9.96 (2.05)

Figure 1. Observed trends between BMI and Learning & Memory.



Results

There were no significant main effects of either BMI or sleep quality on cognitive performance. However, strong trends were observed for the effect of BMI on attention (b=0.127, t(211)=1.883, p=0.061) and learning/memory (b=0.126, t(211)=1.948, p=0.057). Trends were also observed for an effect of PSQI on executive function (b=-0.115, t(211)=-1.834, p=0.069) and processing speed (b=-0.106, t(211)=-1.774, p=0.077).

Conclusions and Clinical Implications

While it was expected that both BMI and poor sleep quality would be associated with reduced cognitive performance, significant main effects were not found. Trends were observed for an effect of BMI on attention and memory, and of sleep quality on executive function and processing speed. One hypothesis for these results is that the deleterious effects of BMI and poor sleep may not manifest until later adulthood and may be weaker or not detected in younger adults. Moreover, an effect of BMI and/or sleep quality may only be observable when comparing normal weight or underweight compared to overweight/obese individuals.

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