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Sleep Quality And Body Composition Indices Of Obese Female Adolescents Improved Using Indigenous *Ampe* Exercise Programme

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Abstract

Background: Participation in the *ampe* exercise programme has been shown to improve the anthropometric and physiological characteristics of children, but its effectiveness on sleep quality and body composition indices of obese female adolescents is yet to be determined. This study confirms that *ampe* exercise programme improves sleep quality and body composition indices in obese female adolescents.

Methods: The study adopted a pretest-posttest experimental design, with fifteen obese female adolescents recruited to participate in a 6-week *ampe* exercise programme. Before and after intervention, sleep quality, visceral fat, body mass index, and waist to hip ratio were assessed. A paired t-test and bivariate analysis were conducted between the sleep quality and body composition indices of the participants.

Results: Body weight (102.33±15.80 < 96.47±15.36, *P=0.000*), body mass index (33.55±2.56 < 31.61±2.55, *P=0.000*), visceral fat (10.23±3.03 <8.47± 2.20), (*P=0.003*), and waist to hip ratio (0.86±0.04 < 0.83±0.05, *P=0.000*) decreased significantly while sleep quality (*P=0.000)* improved significantly after *ampe* exercise programme. The relationship between sleep quality and body composition indices was not significant.

Conclusion: *Ampe* exercise programme potently improved body weight, body mass index, visceral fat, waist to hip ratio, and sleep quality in obese female adolescents. It is an effective and inexpensive therapeutic exercise programme suggested for individuals with non-communicable diseases and mental health. Further, comprehensive clinical trial studies on cardiovascular disease patients will ascertain the clinical efficacy of *ampe* exercise programme.

Key words: Sleep quality, Sleep latency, Sleep duration, Visceral fat, Waist-to-hip ratio.

INTRODUCTION

Obesity, sleep quality, and physical activity are interrelated factors that contribute significantly to overall health and wellbeing. Obesity is frequently influenced by genetic predisposition, dietary choices, a sedentary lifestyle, and a lack of physical activity. Multiple physiological and psychological processes require enough restorative sleep [(1)]. However, poor sleep quality can have negative effects on several aspects of health, such as metabolic function, appetite regulation, and energy balance [(2)]. Participating in regular physical exercise is essential for achieving and sustaining a healthy weight, increasing one's mood, lowering the chance of acquiring chronic illnesses, and promoting cardiovascular health [(3,4)].

Inadequate sleep quality has been linked to an increased risk of obesity and weight gain[(2)]. Sleep deprivation disrupts hormonal regulation, resulting in changes in appetite-regulating hormones such as ghrelin and leptin, which can contribute to increased hunger and appetites, especially for high-calorie foods[(5)]. Obesity, notably abdominal obesity, can cause obstructive sleep apnea, sleep disorder characterised by repetitive partial or complete obstruction of the upper airway during sleep [(6)].

The importance of physical activity in mitigating the negative effects of obesity and poor sleep quality cannot be overstated. Regular exercise promotes weight loss and maintenance, enhances sleep quality, and lessens the severity of sleep disorders like obstructive sleep apnea[(7)]. Wiklund[(8)] opined that exercise regulates appetite, balances energy expenditure, and improves metabolic function, thereby contributing to improved overall health and a reduced risk of obesity.

Obesity has attained the worldwide epidemic proportions, and now roughly 25 percent of adults in industrialised countries are obese [(9)]. In Ghana, the national prevalence of obesity was estimated as 17.1% (95% CI = 14.7–19.5%) with higher prevalence of obesity (20.6% vs 8.0%) estimated for urban than rural dwellers [(10)]. Prevalence of obesity (21.9% vs 6.0%) were also significantly higher in women than men [(10)]. At the regional level, about 43.4%, 36.9%, 32.4% and 55.2% of residents in Ashanti, Central, Northern and Greater Accra region, respectively were overweight or obese [(10)]. Studies by Mohammed and Vuvor [(11)], (2012), and Oduwole et al., [(12)] indicate the prevalence of obesity in Ghana among adolescents is as high as 10.9%.

Physical inactivity prevalence for Ghanaian adolescents aged 11–17 years was 87.9%, as seen in the 2014 global status report on NCDs [(13)]. With the onset of the COVID-19 pandemic, physical activity levels continue in the downward trend globally, with reports showing low adherence to the WHO physical activity guidelines. Stay-at-home programmes during COVID-19 have been implicated in accounting for the downward trend and changes in physical activity patterns (e.g., decreased physical activity and increased sedentary behaviour), despite being vital to stopping the disease's spread [(14)]. According to Hall et al., [(15)], sedentary time may have replaced transportation-related and occupational physical activity during the pandemic due to stay-at-home initiatives and unemployment, as well as a disruption of people's daily routines and the widespread closure of exercise facilities. Emerging self-reported [(16-18)] and device-measured data [(19-20)] suggest that physical activity may have indeed decreased because of the stay-at-home orders among healthy-weight, overweight, and obese individuals, even in developing countries such as Ghana with a high physical inactivity rate.

Encouraging and experimenting with a variety of physical activities to accommodate various interests and fitness levels should be one of the multidimensional and multifaceted approaches required to address the endemic challenges posed by a high physical inactivity rate in developing nations such as Ghana. Based on the poor economic status of the average

Ghanaian, experimenting with ampe, a cheaper, friendly, and motivating indigenous physical activity, might be helpful in reducing the burden of obesity and increasing sleep quality. Ampe is a traditional Ghanaian leisure time activity that is performed by two or more individuals (teams) recognised as Ohyiwa and Opare [21]. Although the only previous study [21] on the efficacy of *ampe* exercise programme (AEP) reported that participation in the AEP showed improvement in the body composition, blood pressure and heart rate characteristics of youngsters, AEP effectiveness on sleep quality and body composition indices in obese female adolescents is yet to be determined. This study will hence be the first report to establish and confirm that AEP improves sleep quality and body composition indices in obese female adolescents.

Material and Methods

Research Design

The effect of *AEP* on the sleep quality and body composition of fifteen obese female adolescents was determined by using a pretest-posttest experimental study design. The participants were relatively healthy, without any significant medical conditions or diseases, had normal blood pressure, falls within age range 18-65 years, had body mass index (BMI) of 30 or higher, and had the ability to participate in the AEP.

Experimental procedure

Individuals who initially showed interest were screened to indicate whether they were eligible suing the inclusion and exclusion criteria. Individuals who were female between the ages of 18 to 25 years, having a BMI of 25 and above, being apparently healthy, have not been diagnosed of any medical condition, being physically inactive, i.e. engaging in ≥ 3 sessions of planned physical activity or exercise per week, and Answer “NO” to all the questions of the Physical Activity Readiness Questionnaire plus (PAR-Q+) and have signed the informed consent form were included in the study. However, obese women who either less than 18 or more than 25years, pregnant or lactating, on any dietary restrictions or chronic medications with the aim to lose weight, or undesirable alcohol consumption (>2 drinks per day) and smoking (> 5 cigarettes per day), living with any form disability or musculoskeletal conditions that can limit or prohibit safe participation exercise participation were also excluded. In addition, volunteers who were living with any reported acute illness, chronic disease or any other medical problems such as of CVD, renal, hepatic and endocrine disorders, as well as intestinal and gastrointestinal surgery during the health screening session that did not necessarily exclude them from physical activity by the PAR-Q+ or have been diagnosed with any of the metabolic disorders (such as hypo- or hyperthyroidism) were excluded.

After meeting the inclusion criteria, the experimental procedure and objectives of the study were explained to the participants. They were given the ability to ask questions and form their own decisions as to whether they want to join the study or not. Following this, those who formed the decision to join the study were given the informed consent to read and sign. On their second visit to the study site, their baseline body composition parameters such as visceral fat, body mass index and waist to hip ratio were measured while quality of sleep was assessed. Participants then underwent a 6-week ampe exercise program after which the baseline data was repeated. The ‘ampe’ exercise programme took place between the hours of 16h00 and 18h00 GMT every day at the KNUST Exercise Physiology laboratory.

The ‘ampe’ exercise programme

AEP was administered to the participants for a duration of forty minutes per session, three times in a week for six consecutive weeks. The

AEP took place during the second week of the study period through to the 7 weeks. To control other confounding effects and the metabolic state, the participants were standardized during all the exercise sessions. Participants were not required to eat for at least two hours before swimming sessions; must not take caffeinated drinks and alcohol at least 12 hours before session; and not do vigorous activities (rating of perceived exertion more than (>) 12 on the Borg scale) or any unusual exercise at least 24 hours before each session and testing. Each section of the exercise program began with a warm-up and ended with a cool down. The 'ampe' exercise sessions was conducted in the evening between 16h00 and 18h00 each day of the session. Participants were strictly and closely monitored and made sure no one get hurt. All exercise sessions took place under the guidance and supervision of the researchers.

Measurements

Body composition

Standardised procedures were used to measure height and weight[22]. Using a single, previously standardised portable weighing scale, weight was measured without shoes to the nearest 0.1 kg. With the use of a height rod mounted on a wall, height was measured without shoes and recorded to the nearest 0.1 cm. Total body fat, visceral fat, muscle mass, and waist-hip ratio were measured using the Omron Body Composition Body Composition Monitor HBF-375. The body mass index (BMI) of each of the individual was calculated as weight in kilograms divided by height in metres squared. The BMI classes adopted are the same as those used by the International Obesity Task Force for the international overweight and obesity [23].

Sleep Quality

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) developed by Buysse et al., [24]. Subjective sleep quality index, sleep latency, duration of sleep, habitual sleep efficiency, sleep disturbances, usage of sleep medicine, and daytime dysfunction are the seven categories along which the PSQI, a 24-items scale, assesses sleep disorders. Total score is established by adding the scores from these seven categories. Responses were anlysed based on most days (and nights) of the previous month. This scale was modified as question 10 (A-E) of the PSQI was excluded because no roommates/partner of the adolescents was involved in the assessment.

Data Analysis

Microsoft Excel and Statistical Package for Social Sciences version 26.1 were used for data entry and analysis. Descriptive statistics were used to examine anthropometric characteristics and sleep quality. Bivariate analysis (paired t-test) of the Pearson correlation was used to test correlation between anthropometric variables, sleep quality and demographics of respondents. Due small sample size of the participants, tests of normality was conducted (table 1) which ascertained that the data was normally distributed with most of the *P values* greater than 0.05.

Table 1: Tests of Normality

Variables df = 15	Kolmogorov-Smirnov[a]		Shapiro-Wilk	
	Pre (Pvalue)	Post (Pvalue)	Pre (Pvalue)	Post (Pvalue)
BMI	-0.176 (0.200*)	0.180(0.200*)	0.928 (.254)	0.960(.693)
Visceral Fat	0.135 (0.256*)	0.224 (0.142*)	0.957(0.914)	0.632 (0.157)
WHR	0.160(0.200*)	0.142(0.200*)	0.894(.078)	0.966(.796)
Subjective Sleep Quality	0.145 (0.036)	0.105 (0.012)	0.603(0.072)	0.350(0.000)
Sleep Latency	0.114(0.200*)	0.123(0.200*)	0.868 (0.000)	0.514(0.000)
Sleep Duration Score	0.119 (0.002)	0.174 (0.131*)	0.758 (0.000)	0.763 (0.000)
Habitual Sleep Efficiency	0.140(0.200*)	0.198 (0.200*)	0.801(0.000)	0.561(0.002)
Sleep Disturbances	0.067(0.200*)	0.199 (0.200*)	0.497(0.007)	0.790 (0.014)
Use of Sleep Medication	0.183 (0.102)	0.161 (0.144*)	0.499(0.012)	0.694 (0.072)
Daytime Dysfunction	0.066 (0.200*)	0.163 (0.200*)	0.643(0.006)	0.763(0.511)

*. This is a lower bound of the true significance. a. Lilliefors Significance Correction.

Ethical Consideration

Ethical approval was sought from the research ethics committee at Kwame Nkrumah University of Science and Technology. Participants were notified that participation is voluntary and that they have the prerogative to withdraw their participation during the study without having to provide reasons. Participants were made to sign the informed consent form before they partake in the study.

Results

The research had fifteen participants ranging in age from 18 to 25, with a mean age of 21.80±2.24 years and height of 174±11.48 cm. Body weight considerably decreased from 102.33±15.80kg to 96.47±15.36 kg and BMI from 33.55±2.56 kg/m2 to 31.61±2.55 kg/m2. There was a decrease in visceral fat from 10.27±3.03 to 8.47±2.20, waist to hip ratio from 0.86±0.04 to 0.83±0.05, and sleep quality scale from 11.13±2.03 to 6.47±1.64 (Table 2).

Table 2: Paired t-test Results on Pre-Post analysis of age and body composition parameters

Variable	Pretest Mean ± SD	Posttest Mean ± SD	95% CI		Mean Diff.	P-Value
			Lower	Upper		
Weight (kg)	102.33(15.80)	96.47(15.36)	4.316	7.403	5.86	0.000*
Height (cm)	174.20(11.48)	174.40(11.51)	-0.429	0.029	-0.20	0.082
BMI (kg/m^2)	33.55(2.56)	31.61(2.55)	1.390	2.476	1.93	0.000*
Visceral fat	10.23(3.03)	8.47(2.20)	0.708	2.891	1.80	0.003*
Waist-Hip Ratio	0.86±0.04	0.83±0.05	0.015	0.042	0.03	0.000*

Body Mass Index-BMI; mean ± standard deviation; *P<0.05, significant difference.

Table 3 revealed that participants had a mean of 2.53±0.516 and 0.53±0.516 for pre and post-test respectively in Subjective Sleep Quality component. In Sleep Latency participants had a mean of 2.33±0.488 for the pre-test and 0.73±0.458 respectively. For the sleep duration score, participants had a mean of 2.73±0.458 for the pre-test and mean score of 0.27±0.458 for that of the post-test. For the Habitual Sleep Efficiency, participants had a mean score of 2.13±1.125 for the pre-test and 0.27±0.458 for that of the posttest. Participants had a mean score of 2.87±0.352 for the pre-test and 1.07±0.258 for the post of that of the Sleep Disturbances. Respectively, participants had a mean of 2.73±0.458 for the pre-test and 0.73±0.458 for that of the pro test for the Use of Sleep Medication. Participants had a mean of 2.80±0.414 for the pre-test and 0.87±0.352 for the pro test respectively for Daytime Dysfunction. For the Global PSQI Score, the participants had a mean of 18.13±1.995 for the pre-test and 4.47±1.125 for the post-test respectively. Significant values were recorded for Sleep quality, sleep latency, sleep duration score, habitual sleep efficiency, sleep disturbances, use of medication, daytime dysfunction, and that of the Global PSQI score.

Table 3: Components of Sleep Quality

Components	Pre (Mean ± SD)	Post (Mean ± SD)	*t*	*P-value*
1: Subjective Sleep Quality	2.53±0.516	0.53±0.516	10.120	0.000
2: Sleep Latency	2.33±0.488	0.73±0.458	12.220	0.000
3: Sleep Duration Score	2.73±0.458	0.27±0.458	14.929	0.000
4: Habitual Sleep Efficiency	2.13±1.125	0.27±0.458	7.299	0.000
5: Sleep Disturbances	2.87±0.352	1.07±0.258	16.837	0.000
6: Use of Sleep Medication	2.73±0.458	0.73±0.458	09.110	0.000
7: Daytime Dysfunction	2.80±0.414	0.87±0.352	29.000	0.000
Global PSQI Score	18.13±1.995	4.47±1.125	29.000	0.000

A Pearson correlation was conducted to assess the correlation between the body composition parameters and sleep quality. Table 4 revealed that there was no significant relationship between the body compositional parameters and sleep quality. Body mass index and waist to hip ratio showed a positive correlation with sleep quality even though it was not significant while visceral fat had a negative relationship with sleep quality.

Table 4: Correlation between Body composition and Sleep Quality

Body composition Indices	Pittsburgh Sleep Quality Index	Pvalue
Body mass index	0.311	0.259
Waist-to-hip ratio	0.123	0.661
Visceral fat	-0.296	0.284

Pvalue < 0.05.

Discussion

The study established the effects of *AEP* on sleep quality and body composition indices. It also looked at the correlation between body composition and sleep quality. The six-week ampe programme had positive effects on all body compositions: body weight, BMI, visceral fat, and waist to hip ratio, except for height as evidenced by reduction in all post-tests means as compared to the pre-test means of almost all variables. This means that *ampe*, another physical activity/form of exercise can significantly improve body weight, BMI, visceral fat, and waist to hip ratio especially among obese people. The findings of this study are in conformity with Moses et al., [21], who reported that a 4-week 'ampe' exercise programme reduced Weight, BMI, Waist-to-hip ratio by a percentage change of 0.31, 0.58 and 0.31 respectively. The study findings also agree with the US Department of Health and Human Services [25], (2018) who found that physical activity can help reduce the risk of excessive weight gain and the incidence of obesity. Moreover, when compared with other forms of exercise, it was also like the findings of Adams et al., [26] who found out that jogging exercise programme reduced the amount of visceral fat in obese individuals significantly. According to Powell-Wiley, et al., [27], a high correlation exists between high adiposity and cardiovascular disease risk and as such reducing visceral body fat, waist circumference and body mass reduces, and individuals risks level.

Sleep quality assessment found that, Sleep challenges were improved after the ampe exposure. +Respondents had better sleep as compared to their initial sleep experiences. They slept early, had reduced sleep latency (taking less time to fall asleep), improved sleep efficiency (higher percentage of time in bed sleeping) and improved sleep quality. This is consistent with findings by the U.S. Department of Health and Human Services [25] who found that exercise reduced sleep latency (taking less time to fall asleep), improved sleep efficiency (higher percentage of time in bed actually sleeping), improved sleep quality, and more deep sleep among obese persons [25]. All other sleep challenges such as waking up at the middle of the night or early morning, getting up to use the bathroom, inability to breathe comfortably, cough or snore, feeling of too cold or too hot, trouble staying awake were all significantly improved. The majority rated their overall sleep to be good. Good quality sleep has been found to help reduce obesity by decreasing energy intake by decreasing hunger. Sleep deprivation may alter the hormones that control hunger [28]. Spiegel et al., [29] found that young men who were deprived of sleep had higher levels of the appetite-stimulating hormone ghrelin and lower levels of the satiety-inducing hormone leptin, with a corresponding increase in hunger and appetite-especially for foods rich in fat and carbohydrates.

Results from this study showed no significant relationships between obesity and sleep quality ($p > 0.259$). Contrary to this study's findings, studies by Mahfouz et al., [30], Erlacher et al., [31] and Wang et al., [32] found significant associations between sleep quality and obesity ($p < .001$). The difference in findings could be due to the use of different classifications on the PSQI which can give different relationships between BMI and sleep quality, which suggests that different classifications of PSQI may influence the study of sleep quality and should be chosen carefully in studies. However, the sleep quality reported in this study is similar to the work of Wang et al., [32], who reported the sleep quality among university adolescents to be 4.91±2.67. Even though this study found no relationship between obesity and sleep quality, it is important to understand that sleep deprivation due to self-induction, insomnia, untreated sleep apnea, or other sleep disorders may lead to metabolic dysregulation [33-34]. Poor sleep is associated with increased oxidative stress, glucose (blood sugar) intolerance (a precursor to diabetes), and insulin resistance [35]. Extra time spent awake may increase the opportunities to eat, and sleeping less may disrupt circadian rhythms, leading to weight gain [35-36].

Conclusions

AEP potently improves quality of sleep, body weight, body mass index, visceral fat, and waist to hip ratio quality in obese female adolescents. *AEP* is an effective and inexpensive therapeutic exercise programme suggested for individuals with non-communicable diseases and mental health. Further comprehensive clinical trial studies on cardiovascular disease patients will ascertain the clinical efficacy of *AEP*. Efficacy of *AEP* on biochemical and cardiovascular risks and other confounding factors such as diet and energy expenditure will also present viable findings.

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