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ORIGINAL ARTICLE

Changes In Emotional Distress And Cognitive Performance Following Aerobic Exercise And Low Fat Milk Consumption In Sedentary Female Adolescents

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ABSTRACT

Introduction: Regular aerobic exercise and low-fat milk consumption can improve certain cognitive functions and reducing emotional distress. However, the impacts of combining these modalities are less explored. Thus, the present study examined the effects of combining aerobic exercise and low-fat milk intake among sedentary female students. **Methods:** Using a nonrandomized pretest – posttest with a control group research design, 85 sedentary females aged 16 years old were assigned into either milk (n = 21), exercise (n = 22), combined low fat milk and exercise (n = 23), or control (n = 19) groups. One serving of low-fat milk was provided to the students during each school day, and a 1-hour supervised step aerobics exercise was conducted twice per week for 3 months. Emotional distress and sustained attention were measured at baseline, 6th and 12th weeks after the intervention. A mixed factorial ANOVA was used to analyse the data. **Results:** The results revealed significantly less emotional distress in the combined ($p < 0.01$) and exercise groups ($p < 0.05$) compared with the control group after 12 weeks. Additionally, significant reductions were observed in the total time taken and errors of omission for both digits 6 and 9 of the Digit Vigilance Test in the combined group ($p < 0.05$, $p < 0.001$) compared with the control group. **Conclusions:** The results showed that low fat milk alone did not provide any additional benefits related to distress regulation, but the combination of exercise and low-fat milk contributed to improving sustained attention.

Keywords: Emotional health, Physical fitness, Aerobic exercise, School food program, Cognitive performance

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INTRODUCTION

Growing evidence indicates that cognitive abilities can be enhanced through regular participation in exercise. Indeed, a review of published studies on the relationship between exercise and cognitive functions found support for the positive effects of exercise on cognitive functioning (1). For example, Davies et al. (1) reported that children aged 7–11 years who engaged in either 20 min or 40 min of aerobic exercise showed better cognitive functioning compared with a non-exercising group. The positive effects of aerobic exercise on cognitive functioning have also been observed in other studies (2-4).

Importantly, prior studies have found that complex exercises that involve coordinating complicated body movements, adapting to changing task demands, and strategic behaviour are more likely to have a positive effect on cognitive functioning than are simpler and repetitive tasks (5). Indeed, exercises such as aerobic dance that involve these forms of movement would be expected to exert more positive effects on cognitive performance (6-8).

Just as enhanced cognitive functioning contributes to academic achievement in school settings, emotional distress tends to be a critical barrier to learning and is often associated with poorer cognitive functioning and academic performance (9-15). Importantly, exercise habits have been shown to play a significant moderating role in the relationship between emotional distress and academic performance (16). Specifically, a study conducted by Hashim et al. (16) found that habitual exercise buffered the combined effects of stress, anxiety, and depression on academic performance among 10–12-year-old students. Indeed, they found that exercise was positively associated with short-term memory and that better short-term memory was associated with better academic performance. As these studies used a cross-sectional design, an experimental study is needed to confirm this relationship.

In addition to exercise, considerable empirical evidence suggests that cognitive functioning can also be enhanced by proper dietary intake (17). For instance, a study of milk consumption conducted by Rahmani et al. (17) with

469 school students over a period of 3 months found significantly higher scores for cognitive performance in the intervention group (8). A study of longer duration conducted by Lien et al. (18) found that students who consumed milk had better recall of memorised words and numbers.

However, a study conducted by Leong et al. (19) over a shorter duration (6 weeks) found that aerobic exercise improved short-term memory but milk did not make an additional contribution to cognitive performance in female high school students. Given the researchers' assumption that a longer duration may enhance the benefits of milk, this finding has been attributed to the shorter milk supplementation regimen used in this study. Although valuable, such a general suggestion leaves unanswered question of how long it would take to reach the benefit threshold. Cognitive ability is an essential prerequisite to students' academic performance. Thus, it is important to develop, implement, and promote strategies that can strengthen these abilities among students and remove barriers to their smooth functioning (19).

To date, few studies have evaluated the impact of combined aerobic exercise and low fat milk supplementation on adolescents' cognitive performance and emotional distress. Therefore, the present study examined the effects of 3 months of aerobic exercise combined with low fat milk consumption (one serving/ day during each school day) on the sustained attention and emotional distress of sedentary female adolescents. We hypothesised that the intervention group would show reduced emotional distress and enhanced cognitive performance.

MATERIALS AND METHODS

The present study utilized a nonrandomized pretest – posttest with a control group research design. This design allows for both within and between group analysis of the data.

Subjects

The final sample consisted of 85 sedentary female students aged 16 years of age who were assigned to the milk (n = 21), exercise (n = 22), combined (n = 23), or control (n = 19) group. All participants were students aged 16 years of age who were living in the school hostel and met the following criteria: not a previous participant in regular aerobic exercise programs or other forms of sports or exercise; medically fit, with no contraindications for exercise; and not a daily consumer of milk or dairy products. Because of the nature of convenient sampling in this study, all students who satisfy the passed the initial screening process, met the inclusion criteria and consent to participate are included in the study analysis. On the basis of this decision, 94 participants were included. The number exceeds the minimal required sample size of 48 participants to reach 80% statistical power, 95% confident interval and effect size of F (0.25) calculated using G*Power Software. From an initial 94 students recruited at the beginning of the study, nine students withdrew for reasons including changing schools (n = 1), missing more than 20% of the aerobic exercise sessions (n = 3), unwillingness to consume milk or lactose intolerance during the 3-month intervention (n = 2), participation in a sports team (n = 1), or choosing to discontinue participation (n = 2). Data from 85 participants was used in the final analysis.

Procedures

This nonrandomized pretest – posttest with a control group research design involved assessments after 6 and 12 weeks of aerobic exercise training and low-fat milk consumption by students from all-girls secondary schools in Kota Bharu. As a result of purposive sampling procedure utilized in this study, all participants were of Malay ethnicity. The Human Research Ethics Committee of the authors' institution, the Ministry of Education, and the school principals provided approval for the recruitment of participants. Participants and their parents were informed about the aims and details of this study, and parents provided signed informed consent at the beginning of the study.

Students in the low-fat milk group received one serving/ day of milk (250 ml for each student) on 5 consecutive days per week for 12 weeks at a specific time in the morning. Participants in the exercise group participated in an aerobic dance session (1hr/session) twice per week for 12 weeks. Those in the combined group received both treatments, whereas participants in the control group received no intervention; they were included only in assessment sessions and were instructed to continue with their current level of activity and diet. Participants were asked not to participate in any other regular physical activity and not to change their diet during the study period. All measurements were taken at the schools 1 week before the intervention program began and again 12 weeks after the start of the intervention program. All measurements were completed on the same day in each school. Measurements of emotional distress and sustained attention were performed at baseline and after 6 and 12 weeks of the intervention program.

Step Aerobic Dance Exercise

Participants in the exercise and combined groups enrolled in supervised step aerobics training at an intensity of 50–85% of their target heart rates. Training was performed 2 days per week in the evening, and each session lasted for 60 min. Each exercise class started with 10 min of warm-up exercises; this was followed by 45 min of low-impact, high-impact, or step-board movements and, finally, by 5–10 min of cooling-down exercises. The exercise intensity and target heart rate were determined for each subject using the Karvonen method.

The intensity of the training load was progressively increased over the course of the intervention as the training volume was maintained. The training intensity was manipulated using music tempo, jumping movements, combinations of hand and leg movements, and stepping. Participants in both high-impact and low-impact exercises were required to perform upper and lower limb movements according to the rhythm of the music. Participants in the step movements were required to step up and step down using a step board.

The tempo of the music was determined according to the intensity of each session. Music with 100–110 bpm was used for warm-up and cool-down sessions, whereas music with 120–150 bpm was used for the aerobic and step-board exercises, as these depended on music for their intensity. Participants were required to perform aerobic exercises in different sets or following certain choreographed patterns. After each set or pattern, their heart rates were measured from the carotid artery within 15 sec and recorded. All participants had been taught to monitor their own heart rate before starting the intervention. The choreographed patterns consisted of arm and leg motions (high or low) that were combined to form single units. The high- and low-impact aerobic movements consisted of the following groups of movements: step touch, march, lunge, knee up, hamstring curl, grapevine, V-step, hop, turn, and jump. The step aerobics consisted of steps belonging to the following groups: basic step, lunge, lift step, tap step, A-step, L-step, cross-over jam, and straddle (20).

To ensure consistency across the combined and exercise groups, the aerobic dance sessions were conducted by two aerobic exercise instructors certified by the Aerobics and Fitness Association of Malaysia. Using a cross-over approach, the instructors alternately attended the groups that participated in this form of intervention. The instructors were given a pre-recorded CD containing aerobics music that was matched to the intensity of each session and aerobic program. Therefore, the sequence, structure, pace, intensity, and music were designed to be exactly the same for the physical-activity-only and the combined groups.

Milk Supplementation

Commercial low-fat milk was used in present study. One serving provided the following approximate amounts of these components: energy (113 kcal), protein (8.0 g), carbohydrates (11.5 g), fat (3.8 g), calcium (338mg), zinc (1.0 mg), iodine (33 μg), vitamin A (400 μg), vitamin D3 (6.25 μg), vitamin B2 (0.33 mg), and vitamin B12 (1.30 μg). Participants in the combined and low-fat milk groups consumed one 250-ml serving of milk in the morning during recess time (5 days per week) for 3 months, except for holidays. Milk provision and consumption were supervised by a researcher or a student representative. The student representative was asked to make certain that all participants consumed the milk at the same time and did not share with others.

Instruments

Depression Anxiety Stress Scale-21 (DASS-21) (21)

Emotional distress was measured using the Malay version of Depression Anxiety Stress Scale-21 (DASS-21)(22), which includes 21 items rated on a scale of 0 (does not apply to me at all over the last week) to 3 (applies to me very much or most of the time over the past week). Scores for all subscales were calculated by summing the scores for the relevant items. Hashim et al. (23) examined the validity of this questionnaire using confirmatory factor analysis with data obtained from 750 13- and 14-year-old secondary school students, and the results showed acceptable factorial validity (CFR = 0.93, RMR = 0.03, PCFI = 0.77, RMSEA = 0.06); the alpha coefficients were 0.68, 0.67, and 0.70 for stress, anxiety, and depression respectively (22).

Digit Vigilance Test (23)

The Digit Vigilance Test (DVT), which consists of two full pages of single digits (59 rows, 35 columns) ranging from 0 to 9 that are randomly arranged on a page, was used to measure sustained attention. Participants were asked to cross out a specific target number (6 or 9) that appeared randomly within the digits on the two pages (the first page in a red font colour, and the second in a blue font colour) as quickly as possible. They were instructed to attend to and focus on each individual number during the test and were told that the time it took to time to complete the test would also be measured. Time was measured in seconds using a stopwatch. Total completion time (TCT) and errors of omission were recorded for both pages separately. Scores involved two indices: a) total time in seconds for pages 1 and 2, and b) total errors on pages 1 and 2 (number of omissions) (23).

Statistical Analysis

SPSS statistical software (version 19) was used to analyse the data. Differences in characteristics between groups at baseline were assessed using one-way analysis of variance (ANOVA). A mixed factorial ANOVA was performed to determine the significance of differences within and between groups. The least-significant-differences (LSD) post hoc test was used to identify differences when the two-way repeated-measures ANOVA revealed significant differences between groups or across test sessions.

RESULTS

The anthropometrical and physiological characteristic of the participants are presented in Table I. The results of One-Way ANOVA revealed no significant different between the experimental and the control groups in height (cm), weight (kg), Body Mass Index (kg/m^2), percentage of body fat, and predicted VO2max. Moreover, the descriptive statistics of the emotional

Table I: Anthropometrical and Physiological characteristic of the participants

Variables	Groups			
	Milk	Combined	Exercise	Control
Height (cm)	152.11 (4.41)	154.08 (4.61)	152.94 (4.62)	154.70 (4.76)
Weight (kg)	48.80 (8.91)	52.32 (11.20)	50.76 (8.36)	49.57 (6.84)
Body Mass Index, BMI (kg/m²)	21.13 (3.25)	21.95 (4.45)	21.69 (3.50)	21.15 (2.28)
Percentage of body Fat (%)	28.35 (5.14)	28.59 (5.77)	28.58 (4.45)	27.72 (3.66)
Maximal Oxygen Consumption, VO_{2max}	37.01 (3.64)	37.08 (4.19)	37.93 (3.63)	37.77 (3.39)

Note: No significant differences between the experimental groups at baseline (p > 0.05)

distress and indices of sustained attention from Digit Vigilant Test total time taken to complete the test and total error are presented in Table II. The Mixed Factorial ANOVA revealed a significant group by time interaction ($F = 6.24$, $df = 6$, $p < 0.001$) for emotional distress scores. Post hoc tests indicated that the intervention groups had significantly lower emotional distress scores on the post-test compared with the control group (Table III). Significant group by time interactions were found for measures of sustained attention, including TCT for both forms of the test (6: $F = 3.26$, $df = 5.23$, $p < 0.001$; 9: $F = 3.82$; $df = 4.13$; $p < 0.001$) as well as for total errors on the digit 6 ($F = 1.72$; $df = 4.63$; $p < 0.05$) and the digit 9 ($F = 2.59$; $df = 4.00$; $p < 0.05$). A post hoc test was performed for those variables in these interactions that were related to sustained attention, and these results are presented in Tables IV and V. Post hoc tests demonstrated that participants who engaged in aerobic exercise and consumed milk showed significantly greater improvements with regard to all variables related to sustained attention compared with control group after 12 weeks.

DISCUSSION

The findings of the present study support the notion that exercise regulates stress. This finding is consistent with the improvement in the cognitive performance and reduction in emotional distress among those who received the combined intervention of aerobic dance and milk for 6 weeks. However, our data also reflected the beneficial effects of combined aerobic exercise and milk and of aerobic exercise alone on both sustained attention and emotional distress after 12 weeks.

The effects of exercise on cognitive performance differ for different types of exercise. Specifically, complex exercises that involve coordinating complicated body movements, adapting to changing task demands, and strategic behaviour are more likely to exert a positive effect on cognitive functioning than are simpler and repetitive tasks (1). Indeed, in contrast to the present study, which used complex coordinated movements,

Table II: Descriptive Statistics of Emotional Distress and Sustained Attention for each experimental group

Groups		Milk	Combined	Exercise	Control
Variables		Mean (SD)			
Emotional Distress	Pre	10.00 (3.69)	11.88 (3.69)	11.31 (4.44)	9.75 (4.88)
	Mid	9.26 (4.11)	8.77 (4.75)	10.77 (4.86)	10.70 (6.29)
	Post	9.34 (4.95)	6.59 (3.12)	7.38 (4.42)	10.65 (6.67)
DVT-T Page 6	Pre	155.17 (24.36)	149.28 (14.41)	157.09 (26.13)	148.30 (24.59)
	Mid	150.43 (24.70)	140.22 (19.64)	153.40 (26.09)	142.70 (18.98)
	Post	131.35 (19.54)	127.44 (11.82)	137.68 (20.38)	141.10 (18.58)
DVT-T Page 9	Pre	153.95 (20.09)	148.50 (21.57)	162.00 (23.71)	159.55 (26.02)
	Mid	145.91 (16.43)	141.94 (16.43)	146.04 (25.12)	153.90 (18.46)
	Post	146.32 (17.04)	136.50 (10.81)	147.45 (18.04)	156.25 (18.39)
DVT-E Page 6	Pre	6.69 (4.97)	7.33 (3.80)	5.82 (3.63)	6.68 (5.25)
	Mid	6.35 (5.72)	5.72 (3.22)	5.27 (2.17)	6.85 (5.25)
	Post	6.91 (5.49)	3.94 (3.38)	4.68 (2.62)	7.00 (4.80)
DVT-E Page 9	Pre	7.57 (5.35)	7.17 (5.12)	8.64 (8.63)	7.90 (6.05)
	Mid	8.83 (4.52)	5.61 (3.26)	7.04 (5.94)	8.90 (8.17)
	Post	8.43 (4.18)	4.11 (2.61)	6.09 (5.48)	9.30 (7.68)

DVT-T, Digit Vigilance Test, total time; DVT-E, Digit Vigilance Test, total error

Table III: Pair Wise Comparisons for Level of Emotional Distress across the Measurement Sessions.

Measurement Sessions	Groups		Mean Difference	SE	P value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Pre	Control	Milk	-0.25	1.43	0.86	-3.09	2.59
	Control	Combined	-2.13	1.52	0.16	-5.16	0.88
	Control	Exercise	-1.56	1.44	0.28	-4.44	1.31
	Milk	Combined	-1.88	1.47	0.20	-4.82	1.0
	Milk	Exercise	-1.31	1.39	0.34	-4.09	1.46
	Exercise	Combined	-0.57	1.48	0.70	-3.53	2.39
Mid	Control	Milk	1.43	1.44	0.35	-1.62	4.50
	Control	Combined	1.92	1.55	0.21	-1.16	5.02
	Control	Exercise	-0.07	1.63	0.96	-3.33	3.17
	Milk	Combined	0.48	1.50	0.74	-2.50	3.47
	Milk	Exercise	-1.57	1.58	0.34	-4.67	1.63
	Exercise	Combined	2.00	1.60	0.21	-1.17	5.18
Post	Control	Milk	1.30	1.51	0.39	-1.70	4.30
	Control	Combined	4.06	1.52	0.00**	1.02	7.09
	Control	Exercise	3.26	1.60	0.04*	0.07	6.45
	Milk	Combined	2.76	1.47	0.06	-0.17	5.68
	Milk	Exercise	1.96	1.55	0.21	-1.13	5.05
	Exercise	Combined	0.79	1.57	0.61	-2.22	3.91

** p < 0.01; * p < 0.05

Table IV: Pair Wise Comparisons for Total Time of Digit Vigilance Test on Digit 6 (DVT6) and Digit 9 across the Measurement Sessions

Measurement Sessions	Groups		Mean Difference	SE	P value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Digit 6							
Pre	Control	Milk	-6.87	7.08	0.33	-20.97	7.23
	Control	Combined	-0.98	7.53	0.89	-15.96	14.01
	Control	Exercise	-8.79	7.16	0.22	-23.04	5.46
	Milk	Combined	5.89	7.29	0.42	-8.62	20.41
	Milk	Exercise	-1.92	6.91	0.78	-15.67	11.84
	Exercise	Combined	7.81	7.36	0.29	-6.84	22.47
Mid	Control	Milk	-7.73	6.98	0.27	-21.62	6.15
	Control	Combined	2.48	7.41	0.74	-12.28	17.23
	Control	Exercise	-10.71	7.05	0.13	-24.74	3.32
	Milk	Combined	10.21	7.18	0.16	-4.08	24.50
	Milk	Exercise	-2.97	6.80	0.66	-16.52	10.57
	Exercise	Combined	13.19	7.25	0.12	-1.25	27.62
Post	Control	Milk	9.75	5.55	0.08	-1.30	20.80
	Control	Combined	13.65	5.90	0.02*	1.91	25.40
	Control	Exercise	3.41	5.61	0.54	-7.75	14.58
	Milk	Combined	3.90	5.72	0.49	-7.47	15.28
	Milk	Exercise	-6.33	5.42	0.24	-17.11	4.45
	Exercise	Combined	10.23	5.77	0.08	-1.25	21.73
Digit 9							
Pre	Control	Milk	5.59	7.00	0.42	-8.35	-8.89
	Control	Combined	11.05	7.44	0.14	-3.77	-21.64
	Control	Exercise	-2.45	7.08	0.73	-16.54	-19.54
	Milk	Combined	5.46	7.21	0.45	-8.89	19.81
	Milk	Exercise	-8.04	6.83	0.24	-21.64	5.56
	Exercise	Combined	13.50	7.28	0.06	-0.99	27.99
Mid	Control	Milk	7.99	6.18	0.20	-4.32	20.29
	Control	Combined	11.95	6.57	0.07	-1.12	25.03
	Control	Exercise	7.85	6.25	0.21	-4.58	20.29
	Milk	Combined	3.97	6.36	0.53	-8.70	16.64
	Milk	Exercise	-0.13	6.03	0.98	-12.14	11.87
	Exercise	Combined	4.10	6.46	0.52	-8.69	16.89
Post	Control	Milk	9.42	5.14	0.07	-0.82	19.66
	Control	Combined	18.36	5.47	0.00***	7.47	29.24
	Control	Exercise	8.79	5.20	0.09	-1.55	19.14
	Milk	Combined	8.93	5.29	0.09	-1.60	19.48
	Milk	Exercise	-0.62	5.02	0.90	-10.62	9.36
	Exercise	Combined	9.56	5.35	0.07	-1.08	20.21

*** p < 0.001

Table V: Pair Wise Comparisons for Error of Digit Vigilance Test on Digit 6 (DVT6) and Digit 9 (DVT9) across the Measurement Sessions

Measurement Sessions	Groups		Mean Difference	SE	P value	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Digit 6							
Pre	Control	Milk	0.15	1.37	0.91	-2.58	2.88
	Control	Combined	-0.48	1.46	0.74	-3.38	2.42
	Control	Exercise	1.03	1.39	0.45	-1.73	3.79
	Milk	Combined	-0.64	1.41	0.65	-3.45	2.17
	Milk	Exercise	0.88	1.34	0.51	-1.78	3.54
	Exercise	Combined	-1.51	1.43	0.29	-4.35	1.32
Mid	Control	Milk	0.50	1.44	0.72	-2.37	3.37
	Control	Combined	1.12	1.49	0.45	-1.85	4.10
	Control	Exercise	1.57	1.42	0.27	-1.25	4.41
	Milk	Combined	0.62	1.45	0.66	-2.26	3.51
	Milk	Exercise	1.07	1.37	0.43	-1.66	3.81
	Exercise	Combined	0.44	1.46	0.76	-3.36	2.46
Post	Control	Milk	0.08	1.31	0.94	-2.51	2.68
	Control	Combined	3.05	1.39	0.03*	0.29	5.82
	Control	Exercise	2.31	1.32	0.08	-0.31	4.94
	Milk	Combined	2.97	1.35	0.03*	0.29	5.64
	Milk	Exercise	2.23	1.27	0.08	-0.30	4.76
	Exercise	Combined	0.74	1.36	0.58	-1.96	3.44
Digit 9							
Pre	Control	Milk	0.33	1.98	0.86	-3.61	4.28
	Control	Combined	0.73	2.11	0.72	-3.46	4.93
	Control	Exercise	-0.74	2.00	0.71	-4.73	3.25
	Milk	Combined	0.39	2.04	0.84	-3.67	4.46
	Milk	Exercise	-1.07	1.93	0.58	-4.92	2.78
	Exercise	Combined	1.47	2.06	0.47	-2.64	5.58
Mid	Control	Milk	0.07	1.74	0.96	-3.40	3.54
	Control	Combined	3.29	1.85	0.08	-0.40	6.98
	Control	Exercise	1.85	1.78	0.30	-1.70	5.41
	Milk	Combined	3.21	1.79	0.07	-0.36	6.79
	Milk	Exercise	1.78	1.72	0.30	-1.65	5.21
	Exercise	Combined	1.43	1.84	0.43	-2.22	5.09
Post	Control	Milk	0.86	1.62	0.59	-2.37	4.10
	Control	Combined	5.19	1.73	0.00**	1.74	8.63
	Control	Exercise	4.20	1.64	0.01*	0.07	6.49
	Milk	Combined	3.32	1.67	0.06	-0.98	4.10
	Milk	Exercise	2.34	1.59	0.14	-0.82	5.51
	Exercise	Combined	1.98	1.69	0.24	-1.39	5.35

*** p < 0.001

Kimball (24) observed no differences between exercise and control groups in an attention test administered after a 9-week intervention involving five 40-min weekly sessions of repeated jumping and running movements (24). The effects of complex exercises on cognitive functioning, motor functioning, and a variety of neurobehavioural systems, such as attention, working memory, verbal learning, and memory, have been observed in other studies (5–7).

It has been hypothesised that exercise involving coordinated movements may lead to general pre-activation of cognition-related neuronal networks. As these neuronal structures are responsible for both coordination and cognition, exercises involving coordinated movements would be expected to have a greater positive effect on the accuracy and speed with which attention and concentration tasks are performed (2).

This finding is consistent with that of other researchers who reported the positive effects of aerobic exercise on emotional distress. For instance, Hemat-far et al. (9) and Chamanabadi et al. (10) found that 6 weeks of aerobic exercise of moderate intensity reduced the levels of depression and anxiety in secondary school students.

The importance of emotional regulation for school-aged adolescents is apparent. It has been shown that psychological distress tends to affect cognitive functioning and consequently academic performance (11). Indeed, studies have shown that symptoms of depression (12), anxiety (13), and stress (14) lead to problems in attention and working memory, lack of motivation, poor attendance, headaches, and fatigue, all of which affect students' cognitive performance and result in poor academic performance. Negative emotional stimuli seem to exert a greater distracting influence than positive emotional stimuli on the cognitive control of most individuals (25). Thus, one can speculate that the aerobic exercises used in this study led to a reduction in emotional distress, which, in turn, improved students' sustained attention.

The present study also indicated the non-significant contribution of low-fat milk to the alleviation of emotional distress, although it was equally beneficial compared with aerobic exercise with respect to cognitive performance. This finding contradicts that of Cui et al (26) who found that consumptions of full fat vs low fat diary products tend to exert different effects on symptoms of depression. Specifically, in Cui et al.'s (26) cross-sectional study involving 1,159 Japanese adults between the ages of 19 and 83, of whom 31.2% (out of 897 males) and 31.7% (out of 262 females) were depressed, the researchers found that a higher frequency of low fat is associated with a decreased prevalence of depressive symptoms. Importantly, this association remains stable even after controlling for potential confounding factors such as age, sex, health status, nutrition status, and lifestyle. The researchers attributed their findings to the lower content of trans-fatty acid found in low fat diary product (26).

Despite significant improvement in the emotional distress and cognitive performance of both the combined and the exercise groups after 12 weeks, the mean differences for the combined group reflected greater improvement than did those of the exercise-only group. Thus, it could be speculated that milk supplementation combined with regular activity may produce a more significant positive effect on mental health and cognitive performance than would milk alone. As mentioned in the Results section, participants in the low-fat milk group, who consumed 250 ml/day of milk, showed no significant improvement in their mental health and cognitive performance. It has been suggested that the impact of micronutrients as supplements or as qualified food on mental health is more robust among individuals who are deficient in micronutrients than it is among normal participants (27). Following this logic, the participants in the present study, who were recruited from students of boarding school and provided with school-prepared food, we speculate that they would not be expected to suffer from micronutrient deficiency. Therefore, it could be speculated that psychological improvement would be more evident in nutrient-deficient participants who receive a diet high in nutrients for a long duration than in the normal population. Indeed, this may be one of the reasons for the lack of significant positive effects in the milk-alone group.

The inclusion of students from all-girl schools of Malay ethnicity, specific age group and the specific milk brand in this study may limit the generalizability of the findings. Moreover, the use of questionnaire is known to be influenced by social desirability bias, despite the emphasis given to the participants to report their feelings as honest as possible. Thus, future studies should replicate the current study design in larger and diverse samples to confirm its generalizability.

CONCLUSION

The study demonstrates supports for the use of aerobic exercise along with a diet high in nutrients to minimise the level of emotional distress and improve the level of sustained attention in students. As explained above, we propose that the most significant effect was produced by aerobic exercise in combination with milk consumption. This proposal gained credence from the finding that the mean differences shown by the exercise-alone group were less than those shown by the combined group. Therefore, it could be suggested that the added consumption of milk by participants in the combined group was more effective in improving negative emotional symptoms and cognitive performance than was aerobic exercise alone.

Step aerobic dance is a specific form of complex coordinative exercise and is acknowledged to provide greater benefits on cognitive-motor functions compared to simple exercises. The findings of the present study suggest that step aerobic exercise not only benefits adolescents' cognitive domain, but was also effective in regulating emotional distress. Improvements in these domains have the potential to foster academic performance for school aged adolescents. The present finding also suggest that combining daily milk consumption has the potential to aggravate the potential cognitive and emotional benefits that can be drawn from exercise alone. Thus, the use step aerobic exercise should be considered within school setting and daily milk consumption should be strongly encouraged.

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