The Association between Adverse Childhood Experiences, Social Support, Body Mass Index, and Physical Activity among Adolescents

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ABSTRACT

Background: *Adverse Childhood Experiences (ACEs) have a noteworthy association with levels of social support and physical activity, which play a role in adolescents' future health. This cross-sectional study aimed to examine the associations between ACEs, social support, Body Mass Index (BMI), and physical activity among adolescents in Samarinda, Indonesia.*
Method: *A sample of 246 participants completed an online self-administered questionnaire. Descriptive statistics, Pearson correlation coefficients, and chi-square tests were used to explore associations among variables. Mediation and moderation analyses were conducted using the PROCESS macro.*
Result: *The findings revealed that ACEs were negatively associated with perceived social support (β = -0.1949, $p < 0.001$) and positively associated with physical activity (β = 0.0834, p = 0.0062). Perceived social support was negatively associated with physical activity (β = -0.2002, p = 0.0004) and partially mediated the relationship between ACEs and physical activity, with a significant indirect effect (β = 0.0390, 95% CI [0.0156, 0.0675]). The moderated mediation analysis revealed that BMI did not significantly moderate the direct or indirect effects, although the indirect pathway remained significant across different levels of BMI. The study demonstrated that perceived social support partially mediated the relationship between ACEs and physical activity. This mediation pathway remained significant regardless of BMI level, while BMI did not show a moderating effect. Conclusion these findings suggest that social support partially explains how ACEs influence physical activity, regardless of BMI.*

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INTRODUCTION

Negative childhood experiences, often referred to as childhood trauma or adversity, include a wide range of detrimental events that take place during childhood.(1) These experiences, which encompass abuse, various household difficulties, and neglect, are considered environmental stressors which can significantly impact both mental and physical well-being in life.(2) Research indicates that adverse childhood experiences (ACEs) are highly prevalent across global populations. For instance, a systematic review of community surveys reported that 33% and 88% of individuals had encountered at least one ACE.(3) In the United States, nearly half of children aged 6–17 have experienced at least one ACE.(4) Similarly, 47% of respondents in the UK reported at least one ACE, while 12% had four or more.(5) In Ireland, over 75% of adolescents reported experiencing hardship before nine years old.(6) Emotional abuse appears to be the most common form of ACE, reported by approximately 33.5% of individuals. Other frequently reported experiences include parental separation or divorce (28.2%), substance misuse within the household (26.8%), domestic violence (17.8%), physical abuse (17.5%), living with someone with a mental illness (16.2%), sexual abuse (11.3%), and having an incarcerated family member (8.1%).(7) These diverse forms of adversity highlight the complex ways in which early life environments could shape developmental trajectories.

The long-term consequences of ACEs are well documented. Exposure to chronic stress during childhood has been shown to disrupt neurodevelopment, potentially impairing cognitive, emotional, and social functioning.(8) These disruptions can persist into adulthood, contributing to a higher likelihood of developing mental and physical health issues such as loneliness (9) and obesity in adulthood.(3,10) In other words, adverse early experiences

negatively contribute to an individual's quality of life. On the other hand, physical activity is widely recognized for its positive impact on physical and mental health, as well as academic performance.(2,9,11–15) According to (16), physical activity refers to any bodily movement produced by skeletal muscles that requires energy expenditure, distinguishing it from structured forms like exercise or sports. Physical activity is associated with multiple benefits for mental health (17), such as reduced stress and anxiety (18), improved cognitive performance and memory (19,20), and a lower risk of depression and chronic diseases.(21,22)

However, adolescents who have experienced ACEs tend to engage in physical activity less frequently. Several studies have found that exposure to negative experiences exposure is associated with more sedentary behaviors and reduced physical activity.(23,24) For example, adolescents with multiple ACEs in the United States were less likely to engage in regular physical activity compared to their peers without such exposure. (23) Data from the Adolescent Brain Cognitive Development (ABCD) study further revealed that adolescents with four or more ACEs spent more time on screens and participated less in physical activity, especially during the COVID-19 pandemic.(24) The psychological and behavioral impact of ACEs, such as low self-efficacy or emotional dysregulation, may reduce motivation to engage in healthy behaviors such as physical activity.(25,26)

Social support may play a crucial role in mediating this relationship. ACE exposure may impair the development of healthy interpersonal relationships and reduce the likelihood of accessing support networks.(27) Adolescents with a history of multiple ACEs frequently report lower perceived support from family, peer, and significant others (28,29), which can further exacerbate psychological distress such as anxiety and depression.(30,31) Importantly, social support has been consistently linked to better mental health and health-promoting behaviors. Support from family and peers in particular is associated with greater participation in physical activity during adolescence.(32–34) In Indonesia's collectivist society, where group harmony and social connectedness are central cultural values, the role of social support may be even more pronounced. In such cultures, relationships with parents, extended family, peers, and even teachers are key influences on adolescents' daily behaviors and emotional regulation. Studies in Indonesia indicate that adolescents often rely heavily on peer and parental support for emotional stability and behavioral guidance.(35,36)

In addition to mental health and physical activity, ACEs have been linked to adverse weight-related outcomes. Longitudinal research shows that childhood adversity increases the risk of overweight and obesity due to stress-related physiological changes and poor health behaviors by age 13 and more significant weight gain between the ages of 9 and 13.(6) Other research supports these findings, showing that adverse childhood experiences are related to unhealthy behaviors such as poor dietary habits, sleep disturbances, and physical inactivity.(23,37) Chronic stress stemming from ACEs is believed to alter physiological processes, such as cortisol regulation, which may contribute to fat accumulation and higher obesity risk.(38,39) Taken together, ACEs, social support, physical activity, and BMI are interconnected factors that jointly shape adolescent health.

In Indonesia, adolescent mental health and lifestyle behaviors have been growing public concerns. According to a national mental health survey, 50% of students report feeling anxious without clear cause, and 20% have thoughts of harming themselves.(40) Although these data reflect the urgency of the issue of adolescent mental health and behaviour, there has been no study that specifically examines the relationship between ACEs, social support, body mass index, and physical activity in one city in Indonesia.(41–43) Despite these concerns, there are limited studies on the prevalence of ACEs, social support types, or physical activity patterns in specific regions such as Samarinda or East Kalimantan. However, recent data from the *Online Information System for the Protection of Women and Children* indicated that Samarinda had the highest number of violence cases against women and children in East Kalimantan, accounting for 138 out of 235 total cases in the province.(44)

This highlights the urgency of examining adverse experiences and psychosocial conditions among adolescents in this area. In collectivist cultures such as Indonesia, adolescents are strongly influenced by close-knit relationships with family, peers, and community figures, making social support a particularly salient factor in their development and behavior. Given the cultural, social, and health context of Indonesia, particularly in a developing city like Samarinda, it is essential to explore how these factors interact. Therefore, this study is important to fill this gap and provide a basis for evidence-based interventions at the local level. This study aims to examine the association between ACEs and physical activity among Indonesian adolescents, especially in Samarinda, with a specific focus on the mediating role of perceived social support and the moderating effect of BMI. It is expected that this research can provide new understanding that is appropriate to the local context, different from most studies conducted in individualistic societies.

METHOD

A cross-sectional study was conducted to investigate the association between adverse childhood experiences (ACEs), social support, body mass index (BMI), and physical activity among adolescents. The study was conducted in May - June 2024 in three junior high schools in Samarinda, Indonesia, following approval from the Commission of Ethical Research for the Health Medical Faculty of Mulawarman University, Samarinda, Indonesia, with Approval Number: 228 (2024). The location of this study was chosen using purposive sampling, the name of the school is not mentioned in this report to maintain the confidentiality of participants and consider the sensitivity of the issues studied.

A total of 246 adolescents of the 1st (7^{th} grade) and 2nd grades (8^{th} grade) of junior high school students participated in the study through convenience sampling. Data were collected via an online self-administered questionnaire distributed through schools (*kuesio.id*). Inclusion criteria were students aged 12–15 years who were enrolled in grade 7 or 8 of junior high school and had been given permission by the school and with their parents' knowledge. Exclusion criteria included students who were unable to complete the online questionnaire independently or did not answer the main study variables. Students were asked to return a signed parental consent form, and only those who submitted the form were provided with access to the online survey link.

ACEs were assessed using the World Health Organization Adverse Childhood Experiences International Questionnaire (WHO ACE-IQ), which covers multiple dimensions of childhood adversity (Cronbach's alpha of 0.655). The ACE score was calculated by summing reported adverse experiences. Responses were rated on a 4-point scale and dichotomized as 0 (never) or 1 (exposure). The questionnaire covers types of adversity, including abuse, neglect, household dysfunction, peer violence, and exposure to community or collective violence.(45) Height and weight were self-reported by the students and used to calculate Body Mass Index (BMI) using the formula: weight (kg) / height (m). Perceived social support was measured by adapting a scale using the Multidimensional Scale of Perceived Social Support (MSPSS, Zimet et al., 1988), which has also been used in previous studies with adolescent participants. (46,47) This measure includes three subscales that assess the quality of perceived support from family, friends, and significant others through 12 items, each of which is represented by 4 items. Participants rated on a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). The instrument of this variable was tested with a Cronbach's alpha of 0.835. All of the instruments were administered in Bahasa Indonesia. This variable was treated as a continuous ratio variable and was not categorized in the analysis. The WHO ACE-IQ and MSPSS were translated using a forward–backward translation procedure and pre-tested on a small group of students (n=20) for clarity.

Physical activity was assessed using three items adapted from the Youth Risk Behavior Survey (YRBS) 4-items questions, focusing on the frequency and intensity of physical activity during the past seven days. *In the past 7 days, did you do physical activity for at least 60 minutes per day on 5 or more days? During the past 7 days, did you do exercises to strengthen or tone your muscles, such as push-ups, sit-ups, or weightlifting, on 3 or more days? During the past 7 days, did you participate in any sports teams (school-based or non-school-based)? Did you walk or ride a bicycle to or from school on most days of the week?* Responses were initially recorded on a scale from 1 (0 days) to 8 (every day), and for analysis purposes, physical activity was treated as a continuous ratio scale and not categorized into dichotomous groups.

Descriptive statistics were computed for all study variables. Bivariate associations were examined using chi-square tests and Pearson correlation coefficients. To test the hypothesized model, mediation and moderation analyses were conducted using PROCESS macro for SPSS. A significance level of $p < 0.05$ was used for all statistical tests. In this model, adverse childhood experiences (ACEs) were specified as the independent variable (X), physical activity as the dependent variable (Y), perceived social support as the mediator (M), and body mass index (BMI) as a moderator of the direct path from ACEs to physical activity.

RESULT AND DISCUSSION

The following is a description of the participant characteristics, including details from schools A, B, and C, which can be seen in Table 1. The characteristics include school grade, ethnicity, and BMI category for each school. The analysis shows no significant difference in gender distribution across groups ($p = 0.547$), with females (56.1%) slightly outnumbering males (43.9%). However, age distribution differs significantly between groups ($p < 0.001$). Participants aged 12 are more prevalent in School A and B but entirely absent in School C. In contrast, age 13 is the most common across all groups, especially in School C. Age 14 is concentrated mostly in School C, while age 15 appears only minimally across the dataset. These results suggest that age plays a significant role in group differences, while gender does not.

Table 1. Characteristic respondents

Variable	School A		School B		School C		Total (n)		p-value
	n	%	n	%	n	%	N	%	
Gender									0.547
Male	41	39.8	31	47.0	36	46.8	108	43.9	
Female	62	60.2	35	53.0	41	53.2	138	56.1	
Age (in years)									<0.001
12	37	35.9	35	53.0	0	0.0	72	29.3	
13	46	44.7	28	42.4	45	48.4	119	48.4	
14	20	19.4	2	3.0	29	37.7	51	20.7	
15	0	0.0	1	1.5	3	3.9	4	1.6	
School Grade									<0.001
7th Grade	61	59.2	66	100.0	0	0.0	127	51.6	
8th Grade	42	40.8	0	0.0	77	100.0	119	48.4	
Ethnicity									<0.001
Banjar	23	22.3	9	13.6	21	27.3	53	21.5	
Betawi	0	0.0	1	1.5	1	1.3	2	0.8	
Bugis	15	14.6	9	13.6	10	13.0	34	13.8	
Buton	13	12.6	1	1.5	1	1.3	15	6.1	
Dayak	3	2.9	2	3.0	1	1.3	6	2.4	
Flores	2	1.9	2	3.0	2	2.6	6	2.4	
Jawa	30	29.1	25	37.9	24	31.2	79	32.1	
Kutai	1	1.0	4	6.1	15	19.5	20	8.1	
Madura	3	2.9	6	9.1	0	0.0	9	3.7	
Makassar	0	0.0	0	0.0	1	1.3	1	0.4	
Toraja	6	5.8	3	4.5	0	0.0	9	3.7	
Others	7	6.8	4	6.1	1	1.3	12	4.9	
BMI Category									0.109
Underweight	60	58.3	34	51.5	31	40.3	125	50.8	
Normal	29	28.2	28	42.4	37	48.1	94	38.2	
Overweight	11	10.7	3	4.5	6	7.8	20	8.1	
Obesity	3	2.9	1	1.5	3	3.9	7	2.8	

The analysis also revealed statistically significant differences in school grade and ethnicity among students from the three schools ($p < 0.001$). This suggests that the distribution of students by grade level and ethnic background varied considerably between School A, School B, and School C. Ethnic composition also differed notably, with certain ethnic groups more prevalent in specific schools. In contrast, no significant differences were observed in terms of parental marital status ($p = 0.605$) and BMI category ($p = 0.109$). This indicates that these variables were relatively consistent across the schools, with similar proportions of students from intact and non-intact families, religious affiliations, and BMI categories. These findings suggest that while some demographic factors vary by school, others remain fairly uniform across the student population.

Table 2. Association between ACEs, perceived social support, BMI, and physical activity among adolescents

Variable	Range	Mean	SD	1	2	3	4	5	6	7
ACEs	0 – 10	3.20	2.238	1						
Social Support	1.00 – 7.00	5.64	1.202	-.363**	1					
Significant others	1.0 – 7.0	5.86	1.430	-.189**	.801**	1				
Family	1.0 – 7.0	5.76	1.572	-.423**	.739**	.381**	1			
Friend	1.0 – 7.0	5.30	1.612	-.231**	.807**	.533**	.341**	1		
BMI	9.38 – 58.96	19.35	5.214	.144*	-0.046	0.057	-0.090	-0.066	1	
Physical Activity	0 – 4	2.00	1.044	.262**	-.295**	-.184**	-.285**	-.221**	0.038	1

Note. **p < .01. *p < .05.

In the next following section explores the relationship between ACEs, perceived social support, Body Mass Index (BMI), and physical activity among adolescents. Based on the findings, the correlation analysis showed that Adverse Childhood Experiences (ACEs) were significantly negatively associated with overall social support ($r = –0.363$, $p < 0.001$), including support from significant others ($r = –0.189$, $p < 0.001$), family ($r = –0.423$, $p < 0.001$), and friends ($r = –0.231$, $p < 0.001$). This suggests that individuals with higher ACE scores tend to report lower levels of perceived social support. Additionally, ACEs were positively correlated with Body Mass Index (BMI) ($r = 0.144$, $p < 0.05$) and physical activity ($r = 0.262$, $p < 0.001$), although the positive association with physical activity may seem counterintuitive and might warrant further investigation.

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A meta-analysis of numerous studies indicated a significant association between ACEs and obesity, along with a positive relationship with overweight status. In particular, individuals with a high number of ACEs are at a substantially greater risk of obesity. Moreover, certain types of ACEs, such as sexual abuse, have also been found to be significantly linked to obesity.(48) Unpleasant experiences during adolescence also warrant serious attention, as this developmental stage is highly vulnerable to the emergence of psychological symptoms such as anxiety, sadness, and loneliness. If left unaddressed, these issues may negatively affect academic functioning and productivity in adulthood.(41) Another study using data from the Healthy Nevada Project confirmed that the number of ACEs is positively associated with increased BMI. Individuals with one or more ACEs are at greater risk of becoming obese, and this risk increases significantly for those with a higher number of ACEs. These findings are consistent across various ethnic groups and highlight that ACEs are an important risk factor for BMI abnormalities in adulthood.(49)

Table 3. Mediating effects of ACEs, perceived social support, and physical activity

Model	Effect (β)	SE	t	p-value	95% CI [Lower, Upper]	Standardized β
Model 1 (Mediator: Perceived Social Support)						
Constant	62.609	0.125	500.981	<0.001***	[60.147, 65.071]	-
ACEs → Perceived Social Support (a)	-0.195	0.032	-60.787	<0.001***	[-0.258, -0.132]	-
Model 2 (Outcome: Physical Activity)						
Constant	28.582	0.369	77.521	<0.001***	[21.320, 35.845]	-
ACEs → Physical Activity (c′)	0.083	0.030	27.615	0.006**	[0.024, 0.143]	0.339
Perceived Social Support → Physical Activity (b)	-0.200	0.056	-35.612	<0.001***	[-0.311, -0.089]	-0.115
Total Effect (Outcome: Physical Activity)						
Constant	28.582	0.369	77.521	<0.001***	[21.320, 35.845]	-
ACEs → Physical Activity (c)	0.083	0.030	27.615	0.006**	[0.024, 0.143]	0.339
Indirect Effect (ACEs → Perceived Social Support → Physical Activity)						
Indirect Effect (a × b)	0.039	0.013			[0.016, 0.067]	-

Note. β: beta; SE: Standard error; t: t-statistic; CI: Confidence interval; Boot. LLCI = Bootstrapped Lower-Level Confidence Interval; Boot. ULCI = Bootstrapped Upper-Level Confidence Interval. ***p < .001. **p < .01. *p < .05.

Family support is the form of social support most strongly associated with ACEs. However, a previous study noted that social support did not moderate the effect of ACEs on subjective well-being. In that study, the measurements of both ACEs and social support might not have been comprehensive enough to accurately capture their respective magnitudes. ACEs were assessed only through experiences of parental maltreatment and school bullying. In this regard, previous study highlighted that childhood abuse can also occur in other significant forms, such as witnessing spousal violence, criminal activity, or substance abuse within the household, emphasizing the importance of a broader assessment.(50) Although social support was assessed through involvement of close relations, key aspects such as network size and broader psychosocial constructs were omitted, despite their relevance in studies on gender-specific intergenerational impacts.(17) Therefore, a more complete evaluation of the social support construct may offer a deeper understanding of its role as a protective factor following ACEs.(51)

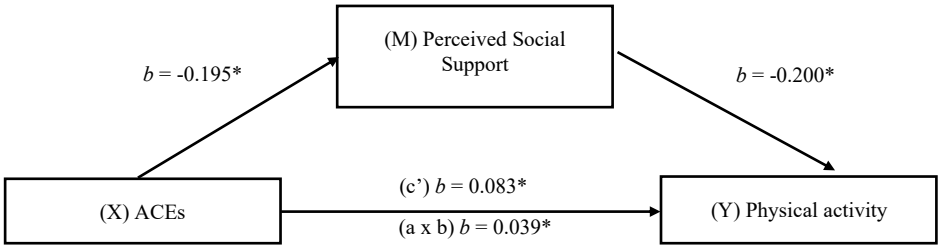
Overall social support was negatively associated with physical activity ($r = –.295$, $p < 0.001$), indicating that individuals with higher levels of perceived support reported lower physical activity levels. Similar patterns were observed in the subscales, where support from family ($r = –0.285$, $p < 0.001$), friends ($r = –0.221$, $p < 0.001$), and significant others ($r = –0.184$, $p < 0.001$) all showed negative associations with physical activity. The correlation between BMI and physical activity was not significant ($r = 0.038$), suggesting no clear relationship between these two variables in this sample.

This table presents the results of the mediating effects of perceived social support in the relationship between Adverse Childhood Experiences (ACEs) and physical activity. The results show that ACEs have a small but significant effect on physical activity, both directly and indirectly through perceived social support. In Model 1, higher ACEs are associated with lower perceived social support ($\beta = -0.195$, $p < 0.001$). In Model 2, ACEs have a small positive direct effect on Physical Activity ($\beta = 0.083$, $p = 0.006$), while perceived social support negatively impacts physical activity ($\beta = -0.200$, $p < 0.001$). In contrast, the analysis revealed a positive direct effect of ACEs on physical activity, which contrasts with much of the existing literature suggesting a negative association. One possible explanation for this unexpected finding is that some adolescents may use physical activity as a coping strategy in response to stress or trauma associated with ACEs. In such cases, engaging in physical activity could serve as a form of emotional regulation, distraction, or a means to regain a sense of control and self-efficacy. Alternatively, this positive relationship might reflect a subgroup of adolescents who are involved in structured activities (e.g., sports clubs) as part of community or school-based interventions targeting at-risk youth.(52–54)

The indirect effect of ACEs on physical activity through perceived social support is also significant ($a \times b = 0.039$, Boot.LLCI = 0.016, Boot.ULCI = 0.067). These findings suggest that ACEs influence physical activity both directly and by reducing perceived social support.

This mediation model illustrates that perceived social support plays a partial mediating role in the association between adverse childhood experiences (ACEs) and physical activity. Individuals with higher ACEs tend to report lower perceived social support, which is associated with lower levels of physical activity. Despite the presence of a direct effect of ACEs on physical activity, the indirect pathway through perceived social support remains significant, highlighting the importance of social support in mitigating the negative impact of ACEs on physical activity behaviors.

The following section presents the analysis of the moderated mediation model, which examines whether the mediation effect of perceived social support in the relationship between ACEs and physical activity is influenced by BMI as a moderator.



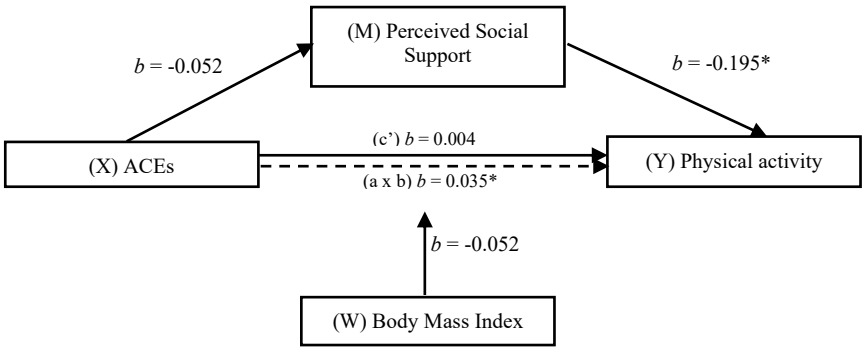
Note. X: Independent variable; M: Mediator variable; Y: Dependent variable; b: Unstandardized coefficient; *p < .05.

Figure 1. Mediation model of ACEs, perceived social support, and physical activity

Table 4. Moderated mediation model of ACEs, social support, BMI, and physical activity

Variables Pathway	Effect (β)	SE	t	p-value	95% CI [Lower, Upper]
ACEs → Perceived Social Support	-0.052	0.103	-0.506	0.613	[-0.255, 0.151]
BMI → Perceived Social Support	0.034	0.026	13.003	0.195	[-0.017, 0.086]
ACEs × BMI → Perceived Social Support	-0.007	0.005	-14.679	0.143	[-0.016, 0.002]
ACEs → Physical Activity	0.001	0.091	0.004	0.997	[-0.178, 0.179]
Perceived Social Support → Physical Activity	-0.195	0.057	-34.465	<0.001***	[-0.306, -0.084]
BMI → Physical Activity	-0.019	0.023	-0.813	0.417	[-0.064, 0.027]
ACEs × BMI → Physical Activity	0.004	0.004	0.972	0.332	[-0.004, 0.012]
Indirect Effect (ACEs → Support → PA) at BMI (16th percentile)	0.031	0.013	—	—	[0.007, 0.059]
Indirect Effect at BMI (50th percentile)	0.035	0.013	—	—	[0.013, 0.063]
Indirect Effect at BMI (84th percentile)	0.042	0.015	—	—	[0.018, 0.076]
Index of Moderated Mediation	0.001	0.001	—	—	[-0.001, 0.005]

Note. ACEs: Adverse childhood experiences; BMI: Body mass index; PA: Physical activity; β: beta; SE: Standard error; t: t-statistics; CI: Confidence interval; ***p < .001. **p < .01. *p < .05.



Note. X: Independent variable; M: Mediator variable; Y: Dependent variable; W: Moderator variable; *b*: Unstandardized coefficient; *p < .05.

Figure 2. Moderated mediation model of ACEs, perceived social support, BMI, and physical activity

The analysis showed that adverse childhood experiences (ACEs) did not have a significant direct effect on perceived social support (b = -0.052, p = 0.613) or physical activity (b = 0.001, p = 0.997). Similarly, BMI and its interaction with ACEs were not significant predictors of either perceived support or physical activity. However, perceived social support emerged as a significant predictor of physical activity (b = -0.195, p = <0.001), indicating that adolescents with lower levels of perceived support tend to be less physically active. Notably, the indirect effect of ACEs on physical activity through perceived social support was small but statistically significant at all levels of BMI. At the 16th percentile of BMI (low BMI), the indirect effect was b = 0.031, 95% CI [0.007, 0.059]; at the 50th percentile (average BMI), it was b = 0.035, 95% CI [0.013, 0.063]; and at the 84th percentile (high BMI), it was b = 0.042, 95% CI [0.018, 0.076]. Although the index of moderated mediation (b = 0.001, 95% CI [-0.001, 0.005]) was not statistically significant, these findings suggest that perceived social support plays a consistent mediating role between ACEs and physical activity across different BMI levels.

The mediation model (Table 3) shows that social support plays a mediating role in the relationship between ACEs and physical activity. Although the direct effect of ACEs on physical activity is not significant, social support has a significant influence on physical activity, where lower perceived social support is associated with higher physical activity. The moderated mediation model (Table 4) tested BMI as a moderator of the pathway between ACEs, social support, and physical activity. While the interaction between ACEs and BMI on both social support

and physical activity was not significant, the indirect effect of ACEs on physical activity through social support remained significant across all levels of BMI, with slightly stronger effects observed at higher BMI percentiles (50th and 84th). However, the index of moderated mediation was not significant, indicating that BMI does not significantly moderate the indirect effect.

The difference between the mediation and moderated mediation models lies in the role of BMI as a moderator. In the mediation model, social support proves to be a significant mediator between ACEs and physical activity. In contrast, in the moderated mediation model, although BMI does not significantly moderate this relationship, the indirect effect of ACEs on physical activity through social support is stronger for individuals with higher BMI. This indicates that BMI can enhance the influence of social support in reducing the impact of ACEs on physical activity.

The study reveals that Body Mass Index (BMI) does not serve as a significant moderating factor in either the direct or indirect effects concerning ACEs and physical activity. This finding is particularly notable as it suggests that neither physical activity levels nor the impact of ACEs on these levels is contingent upon BMI indices. The absence of a significant moderation effect suggests that BMI might not influence how perceived social support mediates the relationship between ACEs and physical activity. One possibility is that BMI serves more as a consequence of behavioral patterns than as a moderator. Another possibility is that adolescents may engage in physical activity as a coping mechanism regardless of their body size, particularly if motivated by emotional distress or peer-related factors.(55,56) Previous literature also indicates that while BMI often correlates with various health outcomes, it does not consistently moderate the relationship between ACEs and physical health determinants.(57) It becomes evident that interventions can be universally applied without the need for tailoring based on BMI, simplifying program design and execution.

Some limitations of this study are as follows, first, the use of a cross-sectional design limits the ability conclude about causality, as the data reflects a single point influenced by participants' desire to present themselves in in time. Second, all information was based on self-reported measures, which may be subject to recall bias or a favourable light. Third, while gender differences could offer valuable insights, this study did not examine gender-specific patterns, suggesting an important direction for future research. Lastly, the sample was drawn from a specific geographic and cultural context, which may limit the generalizability of the results to broader or more diverse populations. Despite these limitations, the study provides meaningful contributions and opens pathways for further investigation. In conclusion, the study's results provide compelling evidence for the mediating effect of perceived social support in the ACEs-physical activity nexus while simultaneously revealing the lack of moderating influence of BMI.

The findings of this study also suggest important practical implications for health promotion practice and policy. First, interventions aiming to enhance physical activity among adolescents with a history of ACEs should incorporate strategies to strengthen perceived social support, especially within the family and peer environments. Programs such as peer-led physical activity initiatives, supportive coaching, and parent involvement in active lifestyles may increase motivation and adherence. In addition, there are a few implications regarding BMI, Adolescents with higher BMI may face unique barriers, such as stigma or reduced mobility, and may benefit from low-impact or enjoyable movement-based activities that build confidence. This underscores the need for inclusive and adaptive physical activity programs that consider individual differences.

CONCLUSION

In conclusion, this study revealed that most participants come from diverse ethnic backgrounds, including Banjar, Bugis, and Javanese. A majority are classified as underweight or normal weight, with fewer in the overweight or obese categories. Significant correlations were found between Adverse Childhood Experiences (ACEs) and different forms of social support, indicating that higher social support tends to be associated with lower levels of ACEs. While BMI showed a weak correlation with physical activity, it was positively linked to ACEs, suggesting that BMI plays a role in mediating the relationship between ACEs and physical activity.

Social support was found to significantly mediate the relationship between ACEs and physical activity. Despite the direct effect of ACEs on physical activity being insignificant, social support positively influences physical activity levels. Additionally, BMI was found to moderate the relationship between ACEs, social support, and physical activity. Although the interaction between ACEs and BMI on social support and physical activity was not significant, the indirect effect of ACEs on physical activity through social support was stronger among individuals with higher BMI, particularly at the 50th and 84th percentile. This indicates that BMI enhances the impact of social support in mitigating the negative effects of ACEs on physical activity.

The cross-sectional design of this study limits the ability to draw causal conclusions about the relationships among ACEs, social support, BMI, and physical activity. The sample was limited to a specific regional and school-

based context, reducing generalizability. Future research should employ longitudinal designs, include more diverse and representative populations, and utilize objective measures of physical activity and BMI. Moreover, examining additional mediators and moderators, such as coping strategies, emotional regulation, or school-based environments, may offer a deeper understanding of the pathways linking ACEs to adolescent health outcomes. Studies should also explore how health promotion interventions, such as peer-led programs or family-centered support systems, can strengthen protective factors like social support and reduce the long-term impacts of early adversity.

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Conflict of Interest

The authors declare that they have no conflicts of interest to disclose.

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