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Effects of Parental Involvement Via Fitness Application on Psychosocial Factors among Overweight and Obese Adolescents in China: A Pilot Study

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Abstract: **Background:** The rising prevalence of overweight and obesity among adolescents poses significant public health challenges, with notable psychosocial consequences such as reduced self-esteem, self-efficacy, and social identity. Parental involvement is recognized as a key factor influencing adolescent health behaviors, yet evidence on technology-mediated family interventions remains limited, particularly in urban Chinese contexts. **Objective:** This pilot study aimed to examine the effects of a parental involvement fitness application (PIFA) intervention on psychosocial outcomes—self-esteem (SES), self-efficacy (SEF), and social identity (SI)—among overweight and obese adolescents in China. **Methods:** A two-week cluster-randomized controlled trial was conducted with 28 junior high school students (aged 12–15) in Jiaozuo City, Henan Province. Participants were randomized at the school level into two groups: the PIFA group (parent-child co-activity via fitness app) and the Individual Fitness App (IFA) group. Psychosocial outcomes were assessed using validated scales at baseline and post-intervention. Data were analyzed using generalized estimating equations (GEE) and effect size calculations. **Results:** The PIFA group showed significantly greater improvements in SES and SEF compared to the IFA group, with large effect sizes (SES: d=0.85; SEF: d=1.23). Significant group-by-time interactions were observed for both outcomes ($p<0.001$). Although both groups demonstrated improvements in SI, between-group differences did not reach statistical significance ($p=0.085$), with moderate effect sizes observed in the PIFA group (d=0.56). **Conclusion:** Parental involvement through a fitness application appears to enhance self-esteem and self-efficacy among overweight and obese adolescents more effectively than individual app use alone. The findings underscore the value of integrating family-based, technology-supported strategies into adolescent obesity interventions. Future studies should address limitations related to sample size, measurement methods, and intervention duration to further validate and optimize such approaches.

Keywords: Fitness application, Parental involvement, Psychosocial, Obesity intervention, Cluster RCT

INTRODUCTION

The Global Burden of Disease Study Obesity Collaborative Group performed a statistical analysis of the obese population across 195 nations worldwide from 1980 to 2015. The findings indicated that 107.7 million children were classified as obese, with the rate of obesity increase among children surpassing that of adults (The GBD 2015 Obesity Collaborators, 2017). Obesity in childhood and adolescence constitutes a significant public health concern in both industrialised and developing nations. The swift proliferation of

obesity has been enabled by changes in dietary and physical activity patterns due to accelerated economic growth in the Asian area.

The World Health Organisation (WHO) reports that the prevalence of overweight and obesity among teenagers globally has attained concerning proportions, with enduring implications for physical and mental health (*Obesity and overweight*, 2021). Adolescent obesity is a major health issue that affects not only physical health but also psychological and social aspects, which are vital for educational success (Cardel et al., 2020). Adolescents with excess weight frequently encounter numerous negative consequences, including heightened susceptibility to chronic diseases, reduced quality of life, and worse social functioning (Swallen et al., 2005).

Overweight and obese teenagers encounter psychosocial issues in addition to physical health implications (Pont et al., 2017). Overweight and obese adolescents frequently encounter social difficulties, including stigma, discrimination, and bullying, stemming from body image issues, which can exacerbate psychological distress (Pont et al., 2017). This, in turn, can adversely impact their academic performance, school engagement, and overall well-being (Langford et al., 2022). The societal stigma associated with weight can result in diminished self-esteem, body image concerns, and a heightened risk of depression (Alimoradi et al., 2020). The psychological burden of perceiving oneself as different or undervalued due to weight can profoundly affect mental health and overall quality of life (Sikorski et al., 2015). Mental health concerns can exacerbate unhealthy eating patterns and sedentary behaviours, establishing a cycle that hinders the adoption of healthier lifestyles (Hoare et al., 2016). In China, overweight and obese teenagers may have distinct psychological issues. In recent years, the dominance of aesthetic standards such as "dressing to appear slender, undressing to appear muscular" and "white, thin, and youthful" has led adolescents who do not conform to these societal ideals to experience feelings of humiliation or inadequacy (Weinberger et al., 2016).

Parental participation is seen as a pivotal factor affecting teenagers' health practices and results (Gregorović Belaić, 2021). Parents play a crucial role in exemplifying healthy behaviours, offering encouragement, and establishing an environment favourable to physical activity (Oranga et al., 2023). Nonetheless, there exists a paucity of studies regarding the specific effects of parental engagement through organised physical exercise on the well-being of overweight and obese adolescents, especially within the urban context of China. The prevalence of fitness applications has escalated in recent years, propelled by the growing global emphasis on health and wellness (Wang et al., 2022). Fitness applications, including Keep, MyFitnessPal, and Strava, offer users accessible and customised resources to track and enhance their physical activity, nutrition, and general health (Mengyao et al., 2024). These applications provide diverse functionalities, encompassing exercise regimens, monitoring features, nutritional guidance, and motivational assistance, tailored to accommodate a broad spectrum of fitness levels and objectives (Shreya Kharche et al., 2023).

Current research has predominantly concentrated on individual therapies aimed at adolescents, neglecting the familial and social environments in which these behaviours manifest. A gap exists in the literature about the effectiveness of family-based interventions, particularly those utilising technology like fitness programs, in enhancing the psychosocial development of overweight and obese adolescents.

METHODS

Study Design

This research utilises a cluster-randomized controlled trial using a two-week repeated measures design.

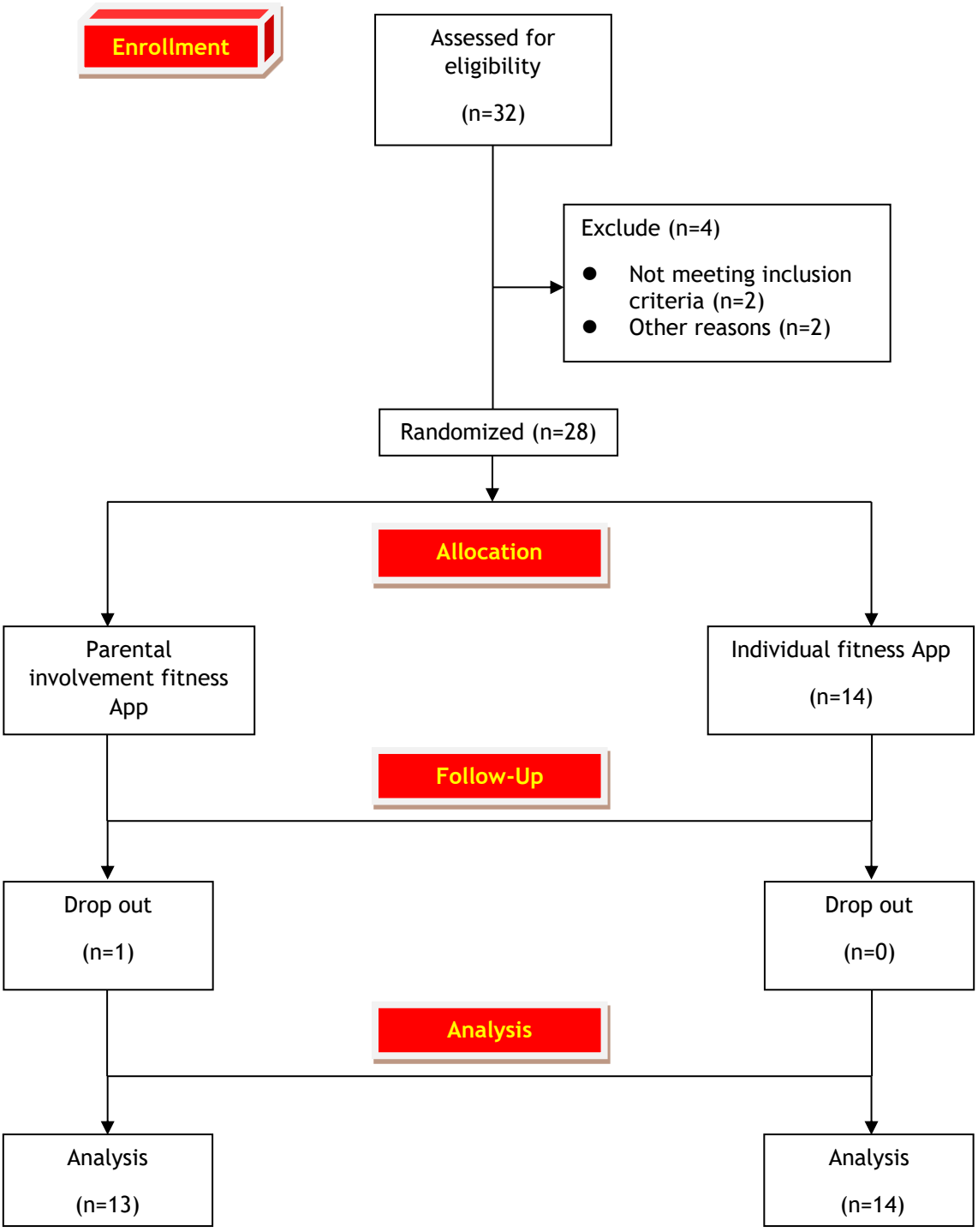

Figure 1: CONSORT 2010 Flow Diagram

Source : (Shaikh et al., 2019)

A quantitative methodology is employed to examine the influence of parental engagement through fitness applications on the well-being of overweight and obese junior high school students (ages 12–15) in Jiaozuo City, Henan Province. Participants were randomly allocated at the school level to one of two groups: the Parental Involvement Fitness App (PIFA) group or the Individual Fitness App (IFA) group.

The CRCT design is especially suitable for this research as it reduces contamination among groups. Randomising at the school level guarantees that each school functions as an independent cluster, given that students within the same institution are prone to share settings, interactions, and effects. This method minimises cross-group contamination and improves the dependability of the intervention's results. All techniques were executed in compliance with the pertinent standards and laws, and the reporting of this cluster randomised trial adheres to the CONSORT 2010/2025 criteria (Figure 1).

Participants

Eligibility Criteria:

- **Inclusion:** (1) The family possesses a mobile phone with Internet connectivity; (2) The age of the participants must be between 12 and 15 years; (3) At least one parent must have sufficient time to assist the child in completing the experimental task within a week; (4) The BMI percentile must exceed 85; (5) Participants should engage in no exercise beyond routine physical activities; (6) Parents must consent to their children's participation in the experiment and be willing to engage alongside them.
- **Exclusion:** (1) Clinically diagnosed mental illness; (2) Clinically diagnosed chronic disease; (3) Use of associated weight reduction medications during the past six months; (4) Single-parent household; (5) Contraindications to physical activity participation as indicated by PAR-Q results.

Outcome Measures

Self-esteem (SES):

This study employs the self-esteem scale developed by Li Shucheng to gather self-esteem data, consisting of 10 questions and utilising a 4-point scoring system (ranging from "1-strongly disagree" to "4-strongly agree"). The overall score varies from 10 to 40, with larger values signifying increased levels of self-esteem. The questionnaire demonstrated strong correlations, with a Cronbach’s α of 0.856 (Li Shucheng & Yang Xiaoyan, 2024).

Self-efficacy (SEF):

This study employed the General Self-Efficacy Scale (GSES) developed by Wu Kaiwen to gather self-efficacy data. There are a total of 10 questions. The content demonstrates an individual's self-assurance in confronting challenges or adversities. The scoring system consists of four levels, with a total range of 10 to 40 points. A higher score correlates with increased self-efficacy. The questionnaire demonstrated strong correlations, with a Cronbach’s α of 0.87 (Wu et al., 2024).

Social Identity (SI):

This study utilised the social identification scale developed by Zhang Danyang to gather social identity data. A total of 16 questions exist. It is categorised into four dimensions: assessment of group status, membership, negative identification, and positive identification. The score is categorised into four tiers. A higher score correlates with an increased level of social recognition. The questionnaire demonstrated strong correlations, with a Cronbach's α of 0.777 (Zhang, 2022).

Statistical Analysis

A generalised estimating equation (GEE) model was employed to assess the efficacy of intervention programs on dependent variables. Generalised Estimating Equations (GEE) enhance the logistic regression model to accommodate clustering (Peters et al., 2003). This thesis presents an analysis of longitudinal data about BMI, waist-to-hip ratio, and physical activity levels among overweight and obese adolescents utilising Generalised Estimating Equations (GEE) under different assumptions of intervention correlations.

RESULTS

Participant Flow and Baseline Characteristics

Of 32 eligible students, 28 (87.5 %) completed the trial (PIFA: n=13, IFA: n=14). Baseline characteristics (Table 1) demonstrated no significant between-group differences in SES (p = .52), SEF (p = .32), and SI (p = .82) confirming successful randomization. (Table 1)

Table 1: Mean Comparison among Groups for Research Variables in Pre-test (Mean, SD)

Variables	PIFA	IFA	F-value	P-value
	n=13	n=14		
SES	20.01 (3.62)	20.12 (3.58)	0.23	0.52
SEF	19.12 (2.31)	19.15 (2.35)	0.28	0.32
SI	50.38 (2.32)	50.48 (2.38)	2.82	0.82

Evaluating the Effectiveness of the Fitness Application Intervention on SES, SEF, and SI between Groups

The effects of PIFA and IFA on psychosocial variables were observed through SES, SEF, and SI. Descriptive data (mean and standard error) for SES, SEF, and SI are shown in Table 2.

The group's main effect on the level of SES (χ^2=4.315, p=.018) was statistically significant. Morever, the effect of time on SES was significant (χ^2=122.25, p < 0.001). Notably, the interaction effect between groups and time (group*time) on SES was statistically significant (χ^2 =32.126, p < 0.001), showing that groups had significant differences over time.

Table 2: Descriptive Statistics (Mean and SE) of SES, SEF, and SI between Groups Across Time

Variables	Time	PIFA	IFA
SES	Pre-test	20.01 (0.561)	20.12 (0.535)
	Post-test	22.48 (0.593)	21.98 (0.526)
SEF	Pre-test	19.12 (0.356)	19.15 (0.257)
	Post-test	20.81 (0.418)	20.16 (0.326)
SI	Pre-test	50.38 (0.285)	50.48 (0.225)
	Post-test	48.25 (0.262)	49.15 (0.210)

The group's main effect on the level of SEF (χ^2=18.123, p < 0.001) was statistically significant. Additionally, the time had a significant influence on SEF (χ^2=202.508, p < 0.001). Notably, the interaction between groups and time (group*time) on SEF was statistically significant (χ^2=52.889, p < 0.001), showing that groups had significant differences over time.

The group's main effect on the level of SI (χ^2=11.584, p < 0.001) was statistically significant. Meanwhile, time had a significant influence on SI (χ^2=125.856, p<0.001). Notably, the interaction between groups and time (group*time) on SI was statistically significant (χ^2=96.051, p<0.001), showing that groups had significant different patterns over time. The details are shown in Table 3.

Table 3: Results of GEE on SES, SEF, and SI Score

Variables	Source	Wald Chi-Square	df	p-value
SES	Group	4.315*	1	0.018
	Time	122.25*	1	<0.001
	Time*Group	32.126*	1	<0.001
SEF	Group	18.123*	1	<0.001
	Time	202.508*	1	<0.001
	Time*Group	52.889*	1	<0.001
SI	Group	11.584*	1	<0.001
	Time	125.856*	1	<0.001
	Time*Group	96.051*	1	<0.001

The mean difference is significant at the*

In order to determine the differences in SES, SEF, and SI between two groups of overweight and obese adolescents across time, the post hoc test (Bonferroni) was applied (Table 4). For SES, there were statistically significant changes (p<0.001) in the PIFA and IFA groups between two different times (pre-test and post-test). The results of effect size indicated that time had a large effect size in the PIFA group (d=0.85) and a small effect size in the IFA group (d=0.29).

For SEF, there were statistically significant changes (p<0.001) in the PIFA and IFA groups between two different times (pre-test and post-test). The results of effect size

indicated that the time had a large effect size in the PIFA group (d=1.23) and a medium effect size in the IFA group (d=0.48).

For SI, there were statistically significant changes (p<0.001) in the PIFA and IFA groups between two different times (pre-test and post-test). The results of effect size indicated that time had medium effect sizes in the PIFA group (d=0.56) and a small effect size in the IFA group (d=0.26).

Table 4: Pairwise Comparison of SES, SEF, and SI Mean Score across Time for Two Groups

Variables	Groups	Mean Difference (Pre-Post)	SE	p-value	95% CI		Effect Size (d)
					Lower	Upper	
SES	PIFA	-4.67	0.348*	<0.001	-4.53	-3.25	0.85
	IFA	-1.84	0.353*	<0.001	-2.53	-0.85	0.29
SEF	PIFA	-4.42	0.355*	<0.001	-5.21	-3.63	1.23
	IFA	-0.92	0.136*	<0.001	-1.26	-0.86	0.48
SI	PIFA	-0.85	0.157*	<0.001	-1.26	-0.36	0.56
	IFA	-0.63	0.123*	<0.001	-1.31	-0.45	0.26

The mean difference is significant at the*

The post hoc (Bonferroni) test was applied to compare the mean value. The results are summarised in Table 5. For SES, at the pre-tests, comparisons between groups indicated no significant difference (*p*=.452), yet at the post-tests, there was a significant difference between the two groups (*p*=.001). The effect size was calculated between groups at two different times (pre-test and post-test); the results indicate that there was a small effect size, d=0.08 at pre-test, as well as a large effect size, d=0.82 at post-test.

Table 5: Pairwise Comparison among Groups at Pre-test and Post-test for SES, SEF, and SI

Variables	Time	Between Groups	Mean Difference	p-value	95% CI		Effect Size (d)
					Lower	Upper	
SES	Pre-test	PIFA vs IFA	0.26	0.253	-1.04	1.56	0.08
	Post-test	PIFA vs IFA	2.23*	0.001	1.23	3.32	0.82
SEF	Pre-test	PIFA vs IFA	-0.06	0.889	-0.85	0.79	0.03
	Post-test	PIFA vs IFA	2.79*	<0.001	2.36	4.32	1.56
SI	Pre-test	PIFA vs IFA	0.56	0.256	-0.29	1.65	0.32
	Post-test	PIFA vs IFA	1.23	0.085	-0.16	2.10	0.43

The mean difference is significant at the*

For SEF, no significant difference was seen between groups at the pre-test (*p*=.889), while there was a significant difference at post-test (*p*<0.001). The effect size results

indicated a small effect size, d=0.03 at pre-test, as well as a large effect size d=1.56 at post-test.

For SI, there were no significant changes between PIFA and IFA at pre-test. The effect size results indicated two medium effect sizes d=0.32 at pre-test and d=0.43 at post-test.

DISCUSSION

The increase in self-esteem among PIFA participants corresponds with current evidence highlighting the significance of family participation in adolescent psychological development. A meta-analysis conducted by (Pinquart, 2023)revealed that family-based therapies yielded moderate positive effects on self-esteem, especially when parents engaged in shared activities. Furthermore, studies indicated that combined physical activities between parents and children were associated with enhanced self-esteem and a positive body image among Chinese teenagers, underscoring cultural significance and contextual importance (Lai et al., 2024; Liang et al., 2024).

The mechanisms contributing to the enhancement of self-esteem may encompass positive reinforcement, emotional support, and social comparison (van Schie et al., 2023; Will et al., 2017). Engaging in exercise with a parent might enhance teenagers' confidence by providing quick feedback and support, as suggested by (Lee et al., 2021). By engaging in synchronous activities and collective accomplishments, children can internalise a sense of competence and worth (Akbar & Abidin, 2018; Rabinowitch & Meltzoff, 2017). When parents exemplify tenacity and convey confidence in their child's endeavours, adolescents are more inclined to develop improved self-concepts (Čerešník & Boleková, 2025; Xing et al., 2024).

Nonetheless, it is crucial to recognise that the enhancement in self-esteem may also indicate social desirability bias, particularly as self-esteem was assessed by self-report measures (Rosenberg Self-Esteem Scale) (Leising et al., 2016). Although the quantifiable improvement is substantial, confirmatory studies employing multi-informant or observational approaches would enhance validity (Hirschmüller et al., 2018; Mason et al., 2020). Furthermore, variations in baseline self-esteem across participants, which were not controlled as factors in the original analysis, may have affected post-intervention scores (Lahav et al., 2013; Ngo et al., 2020).

This result is corroborated by both theoretical and empirical research highlighting the significance of parental participation in augmenting teenagers' sense of self-efficacy. Bandura's Social Cognitive Theory posits that self-efficacy is derived from enactive mastery, vicarious experience, verbal persuasion, and physiological sensations (Bandura, 1999). This study suggests that structured parent-child exercise offered adolescents numerous opportunities to succeed with a trusted role model, hence enhancing their perceived talents through encouragement (Lai et al., 2024; Rachele et al., 2017).

Empirical research highlights this process. De La Torre-Cruz (2017) discovered that parental support, especially through modelling and encouragement, was substantially correlated with youth physical activity, both directly and indirectly through enhancements in self-efficacy (De La Torre-Cruz, 2017). Cozett and Roman (2022) also underscore that programs aimed at augmenting parental participation result in enhancements in

adolescents' motivation and persistence, partially attributable to increased self-efficacy (Cozett & Roman, 2022).

There exists substantial evidence from meta-analytic study. Glatz et al. 2024 assert that parental self-efficacy and involvement are significant predictors of favourable child outcomes, including enhanced self-efficacy in the child. Likewise, initiatives that actively educate parents—such as the Triple P (Positive Parenting Program)—have consistently enhanced children's self-efficacy through directed parental reinforcement and organised participation (Sanders, 2008).

Notwithstanding substantial evidence, use self-report measures to assess self-efficacy entails drawbacks. Adolescents' reactions may be affected by social desirability or ephemeral emotional states. Utilising teacher or parent evaluations for triangulation may improve assessment validity (Jederlund & Von Rosen, 2023; Trost et al., 2003).

Social identity denotes an adolescent's perception of belonging, connectivity, and association with social groupings, including family or peer communities (Wei et al., 2024). Recent research highlights the significance of parental engagement in enhancing family-oriented social identification and adolescents' relational self-concept (Becht et al., 2017). In our study, the PIFA intervention may have enhanced teenagers' social interaction by strengthening the family as a collective activity unit, particularly through repeated parent-child exercise sessions.

While cooperative exercise may create a setting that strengthens family identity, its impact on social identity varied among individuals. Certain teenagers indicated a heightened sense of identification with familial and peer networks as they collaborated with their parents in efforts and achievements (Branje et al., 2021). For these individuals, the organised and supportive framework of PIFA may have enhanced their view of the family as a unified, health-focused entity (Park & Cho, 2022; Zdanowicz et al., 2004). Nonetheless, the aggregate increases in social identity did not attain conventional significance levels, potentially due to insufficient intensity or the lack of explicit identity-enhancing elements in the intervention (Pellet et al., 2024; Steffens et al., 2021).

Research indicates that interventions specifically aimed at fostering group identity—such as team-oriented activities or identity salience tasks—produce more significant effects on social identity than those dependent on incidental social interactions(Crocetti et al., 2025; Haslam et al., 2018; Steffens et al., 2021). The impacts on social identity (SI) identified in PIFA may have been ancillary to its primary health-focused design rather than intrinsic to it.

Furthermore, variations in baseline social identity, familial cohesion, or peer affiliation may have influenced the intervention's effectiveness (Becker et al., 2022; Brincks et al., 2023). Adolescents with robust familial connections may have undergone negligible alterations, whereas those with poorer initial social integration may have derived more advantages (Heshmati et al., 2020; Milburn et al., 2020). Regrettably, no subgroup analyses were performed to investigate these possibilities.

Notwithstanding these constraints, the observed trend and qualitative input from certain participants indicate that parental co-participation in shared activities may, if little, augment adolescents' affiliation with familial or supportive groups. Future interventions may

enhance these effects by explicitly integrating identity-building activities, collective goal-setting, or peer-group participation (Koo et al., 2021; Taylor et al., 2020).

CONCLUSION

This pilot study investigated the effects of a parent-involved fitness application intervention on psychosocial outcomes among overweight and obese adolescents in China. The findings indicate that adolescents in the Parental Involvement Fitness App (PIFA) group demonstrated significantly greater improvements in self-esteem (SES) and self-efficacy (SEF) compared to those in the Individual Fitness App (IFA) group. Although both groups showed positive changes over time, the effect sizes were consistently larger in the PIFA group, suggesting that structured parental involvement amplifies the psychosocial benefits of technology-supported physical activity interventions.

The results underscore the importance of integrating family-based strategies into adolescent obesity interventions, particularly within a Chinese cultural context where familial influence remains strong. The significant interaction effects observed between group and time further support the potential of parent-child co-activity to enhance adolescents' psychological well-being through mechanisms such as modeling, shared accomplishment, and reinforced encouragement. However, changes in social identity (SI) were less pronounced and did not reach conventional significance between groups, indicating that identity formation may require more targeted or intensive relational components beyond joint physical activity. Future interventions could benefit from explicitly incorporating identity-strengthening activities, peer involvement, or family-system approaches to foster a stronger sense of social belonging.

Despite its promising findings, this study has several limitations, including a small sample size, reliance on self-reported measures, and a short intervention period. The exclusion of single-parent households also limits generalizability. Future research should employ larger, more diverse samples, longer intervention durations, and multi-informant assessments to validate and extend these preliminary results.

In summary, this pilot study provides initial evidence that parental involvement via fitness applications can positively influence key psychosocial factors among overweight and obese adolescents. Such integrated, family-friendly approaches hold promise for developing more holistic and effective public health strategies to address adolescent obesity and its associated psychological challenges.

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