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ORIGINAL PAPER

Adaptation and Feasibility of the Mandarin Version of PEERS® for Autistic Adolescents

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Abstract

Purpose: The Program for the Education and Enrichment of Relational Skills (PEERS®) is a group-based social skills training program for adolescents on the autism spectrum. Although the program has been shown to be effective in improving social skills in autistic adolescents, evidence of its effectiveness from the Mandarin-speaking Chinese population is sparse. The present study used a non-randomized, pre- and post-intervention research design to investigate the feasibility and cultural validity of the program, as well as examine the moderators of intervention outcomes. **Methods:** Thirty-three autistic adolescents with intelligence quotient above 70 (M_{age} = 13.57, SD_{age} = 1.43; Male: Female 25:8) and their parents received 14 concurrent 90-minute sessions. Adolescents' autistic traits, challenging behaviors, emotional functioning, socio-cognitive process, social environment factors (school support), and caregivers' well-being were evaluated. **Results**: The findings suggest that with minor adjustments, the Mandarin version of PEERS® was generally acceptable and feasible for autistic adolescents and their parents. PEERS® may improve the social skills knowledge, reciprocal communication abilities, and emotional well-being of autistic adolescents. Also, participants with a higher level of school support, and parents with lower perceived subjective well-being at baseline may gain more benefits from PEERS®. The cultural adaptation and acceptability of the Mandarin Version of PEERS® were discussed. **Conclusion**: This feasibility study (Chinese Clinical Trial Registry: ChiCTR2200061417, 2022-06-23, retrospectively registered) provides a basis for further randomized control trials of the Mandarin version of PEERS®.

Keywords Adolescents · Autism · Social skills group training · PEERS® · Cultural adaptation · Moderators

Friendship plays a vital role in the psychological development of adolescents. Positive peer interactions are crucial to fostering and sustaining adolescents' psychosocial well-being (Barnes et al., 2007; Mitic et al., 2021). Autistic adolescents often show a high desire to make friends (Black et al., 2022), despite ongoing challenges with social communication and interaction (American Psychiatric Association, 2022). In particular, they often lack the necessary social skills to form and sustain dependable relationships. Therefore, delivering effective interventions to improve the social skills of autistic adolescents is critical.

The Program for the Education and Enrichment of Relational Skills (PEERS®) is one of the most evidenced-based social skills group training (SSGT) interventions for improving social skills and adaptive functioning in autistic adolescents (Gilmore et al., 2022; Laugeson et al., 2012; Zheng et al., 2021). Nonetheless, the intervention feasibility and efficacy of PEERS® for adolescents in Asia are still preliminary (Shum et al., 2019; Yamada et al., 2020; Yoo et al., 2014; Zu et al., 2020, 2022). Hitherto, only one study conducted in Hong Kong, China has systematically investigated the efficacy of PEERS® for adolescents within Chinese culture (Shum et al., 2019). Shum et al. found that akin to PEERS® studies carried out in Western countries, Chinese adolescents had enhanced social skills knowledge and decreased autistic traits following the PEERS® training.

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Their findings support the validity of PEERS® administration in Chinese culture.

Nevertheless, the social and family discrepancies between the East and the West may influence the appropriateness of PEERS®. For instance, results from the Hong Kong study showed that the get-together frequencies among Chinese adolescents did not significantly increase post-intervention as in Western cultures (Shum et al., 2019). Their findings were commensurate with the findings reported by South Korea (Yoo et al., 2014) and Japanese researchers (Yamada et al., 2020). Besides, their study also suggested that Chinese parents were less competent than Western parents in applying constructive advising techniques (Shum et al., 2019).

Additionally, Chinese parents are less willing to disclose adolescents' diagnosis conditions to the schools than their Western counterparts. This phenomenon might lead to less collaboration between schools and families. School support might be imperative in determining the acceptance and support autistic adolescents receive from outside their families (Clark et al., 2019). Consequently, lower support from schools could restrict the benefits of SSGT. In brief, cultural aspects should not be overlooked when appraising the appropriateness and efficacy of psychological interventions.

On the other hand, the potential factors that would moderate the intervention outcomes of PEERS® have yet to be thoroughly studied. Previous research has manifested that the PEERS® intervention can meliorate parents' psychological well-being, including lower parental stress and better family functioning (Corona et al., 2019; Karst et al., 2015). These studies, nevertheless, have seldom probed into the effect of parents' psychological status at baseline on adolescents' improvement post-intervention. While parental involvement is an indispensable facilitator in interventions tailored for autistic adolescents (Spain & Happé, 2019), parents' emotional well-being might profoundly impact parental engagement during the interventions (Haine-Schlagel & Walsh, 2015).

Apart from parents' mental well-being, the psychological characteristics of autistic adolescents may influence the training effects. For example, inadequate mentalizing in adolescents would lead to nonconstructive social interactions and relationship disconnection (Bateman & Fonagy, 2004). Previous research has proven the importance of mentalizing in adolescent peer problems (Venta & Sharp, 2015). Also, previous investigations on SSGT revealed that adolescents with less significant internal problems at baseline benefited more from SSGT (Deckers et al., 2016; Dekker et al., 2021; Gerber et al., 2022).

In this study, a cultural revision of the Mandarin version of PEERS® was undertaken, and its feasibility and cross-cultural validity were investigated. Notably, this adaptation (referred to throughout as "Mandarin PEERS®") differs from the officially published Chinese translation of the PEERS® manual (Laugeson & Frankel, 2010a, b/2020), which was translated literally from English into Simplified Chinese without accounting for cultural differences. The study objectives were as follows. (1) Quantitative effect of the intervention on primary outcomes (knowledge of social skills and autistic traits), secondary outcomes (challenging behaviors, well-being, emotional functioning, and mentalization), and caregivers' well-being (emotional functioning, parental competence, and global life satisfaction); (2) to examine the cultural appropriateness of PEERS® through questionnaires with parents and adolescents; and (3) to explore the moderating factors that influence the effectiveness of PEERS®, leading to a more comprehensive understanding of the characteristics of intervention responders. The above results can provide evidence for the use of PEERS® in Mandarin-speaking populations, filling a gap in previous research, making PEERS® more China-culturally appropriate, and laying the foundation for further evaluation of its effectiveness.

Methods

Feasibility Study Design

Reporting followed the guidance for feasibility trials (Lancaster & Thabane, 2019). This was a mixed methods feasibility study incorporating quantitative and qualitative questionnaires, and quantitative data collected from the training program. This study employed a one-group, pre-, and post-intervention research design to investigate the preliminary efficacy of the program and examine the moderators of intervention outcomes.

Recruitment, Eligibility Screening, and Enrollment

Participant recruitment was conducted via multiple avenues, including word-of-mouth, advertisements shared by the clinic, and articles published on the WeChat© Official account. The general framework, overall objective, participation cost, and target population of PEERS® were explained to candidate participants and their parents. Parents would complete an online registration questionnaire if their adolescents desired to participate. After parents had submitted the registration questionnaire, research assistants would have a preliminary screening on the eligibility of candidate participants. Research assistants would further contact qualified candidate participants' parents and conduct prescreening phone interviews. Finally, if candidate participants satisfied the prescreening criteria, candidate participants and parents

would come to the clinic for a 50-minute face-to-face intake interview. Adolescents and their parents would have about 20 min of private interviews separately. They would be informed about the followings: program details, what they might anticipate, and what was expected of the adolescent and parent. For more information regarding the registration questionnaire and prescreening phone interview, please refer to Online Resource 1.

Participants were deemed eligible if they met the following criteria: (1) age between 12 and 17 years; (2) with a diagnosis of autism spectrum disorder according to either DSM-5 or DSM-IV. The diagnosis was verified by the Autism Diagnostic Observation Schedule-Generic (ADOS-G) (Lord et al., 2000) and the Autism Diagnostic Interview-Revised (ADI-R) (Lord et al., 1994); (3) full-scale intelligent quotient (FSIQ) > 70 and verbal IQ > 70 as measured by the Wechsler Intelligence Scale for Children-IV Chinese version (WISC-IV) (Zhang, 2009); (4) both the adolescent and parent were willing to cooperate and participate in the program and scientific assessment and could complete the questionnaires independently. Participants were excluded if they: (1) had a brain injury, cerebral palsy, severe hearing impairment, severe visual impairment, and severe metabolic disease; (2) had significant rule-breaking, aggressive, self-injurious, and wounding behaviors within the last six months; (3) the adolescent clearly expressed refusal to participate; (4) had difficulties with Chinese characters reading comprehension or Mandarin expression and comprehension; and (5) had prior or current co-occurring psychiatric conditions in the history taking that may interfere with participation or require other intervention. In addition, all enrolled families reported that at least one regular parent would be available to attend each session. Following the intake interview, informed consent forms would be obtained if the participants met the criteria.

Translation and Adaptation of the PEERS® Manual

The English version of the PEERS® Manual (Laugeson & Frankel, 2010a, b) was translated into Mandarin Chinese by research team members who had received the PEERS® Certified Teleconference Training. The wording of translated version was further modified to be more felicitous after pre-piloting the program with 5 adolescents and their parents (Online Resource 1). These pre-piloting participants were not re-involved in the present feasibility study. The next stage involved a focus group of 5 clinicians (developmental-behavioral pediatricians, a clinical psychologist, and occupational therapists) experienced in working with Chinese autistic adolescents, providing feedback on the cultural appropriateness of the PEERS® Mandarin Chinese program. The overall curriculum remained unchanged; however, minor adjustments were made to ensure that the Mandarin version of PEERS® was culturally adapted (pre-pilot study period from 2019/12 to 2020/07, Online Resource 2). Role-play scenarios and scripts were re-adapted to suit the Chinese cultural context. Based on the preliminary research (Shum et al., 2019) and parents' desire for more information about aiding their adolescents in building up and generalizing the new social skills in the pre-piloting study, the reunion section of parents and adolescents was also extended (see the intervention part below to have more information). Moreover, we provided every parent with a summary and suggestions on their adolescent's class performance after each session.

Owing to the COVID-19 pandemic, a fraction of sessions were given remotely. Telehealth sessions were held during 2021/05–07 (session 6–11) and 2022/04/17–18 (session 6). We referred to the PEERS® telehealth program and applied to Tencent Meeting (www.tencent.com) to provide these sessions. Parents and adolescents had their sessions separately at different times so that parents could supervise and facilitate their adolescents during the online courses. For structures and descriptions of the telehealth sessions, please refer to Online Resource 2.

Intervention and Setting

In this study, PEERS® was delivered to 4 small groups with 6–10 autistic adolescents each from December 2020 to June 2022. According to the PEERS® manual (Laugeson & Frankel, 2010a, b), the training consists of 14 weekly 90-min concurrent sessions for adolescents and their parents in separate rooms. Adolescents and parents would attend respective sessions in separate classrooms. In the adolescent group, one group leader led each concurrent session with two behavioral coaches. Every adolescent session, except for the first session with no homework review, followed a coherent and congruous structure: beginning with a group rules reminder, followed by reviewing and troubleshooting homework assignments from the previous week. Then, a didactic lesson on a weekly topic was followed. The session ended with assigning homework for the coming week and a recapitulation of the new topic. Adolescents would award bonus points throughout the session when they answered questions aptly or demonstrated their rehearsals. Group rules with cartoon photos and a bonus list were placed on the board in front of the classroom. Regarding the parent group, homework review would be the greatest focus. After that, parents would briefly go over the didactic lesson with the group leader using a parent handout. Parents and adolescents would reunite during the adolescent activities or behavioral rehearsals.

All trainers were clinicians with educational backgrounds in Rehabilitation and Occupational Therapy, Applied Psychology, or Developmental-behavioral Pediatrics experienced in working with autistic adolescents and had received 14-session intensive training in PEERS® from certified PEERS® providers. Besides, certified PEERS® providers would conduct regular trainers' supervision to ensure the program's integrity. Trainers and behavioral coaches would have group meetings before and after each session to ensure that they were able to cover all the materials.

Data Collection and Measurements

All questionnaire data were gathered online using the Tencent Questionnaire platform (Tencent, 2022) and delivered via QR codes. Adolescents and parents filled in separate questionnaires. They completed the questionnaires one week before the intervention started and at the end of the intervention. They were also invited to fill in a feedback questionnaire (parent and adolescent versions, respectively) appraising the training program at the post-test. To ensure privacy, every family would use a unique research identity code when filling in the questionnaires. All questionnaires were administered in Mandarin.

Demographic Data and Adolescents' Characteristics

Adolescents' demographics and diagnostic conditions were acquired through medical records. Family demographics, whether both parents had undertaken social coaches of adolescents, parents' perceptions of school support, and whether adolescents' schools were aware of adolescents' diagnostic statuses were collected via a project-developed online questionnaire. Family demographics included the annual household income, parents' birth dates, and parents' educational attainments. Parents assessed school support during the intervention on a scale of 1 (almost none) to 10 (very high).

Primary Outcome Measures

Test of Adolescent Social Skills Knowledge (TASSK). This 22-item measure was developed and tailored to the social skills taught during the PEERS® curriculum (Laugeson & Frankel, 2010a, b). Adolescents were asked to choose the best answer from the two provided options to complete the sentence, with each correct answer adding one point to the total score. In this study, the Mandarin version of TASSK was developed following the translation/back-translation procedure by two bilingual translators (ZH, BW) (Beaton et al., 2000). Then the back-translated and the original English versions were compared, and discrepancies were noted and modified by the research team. Previous studies on the PEERS® program have exhibited that TASSK is a reliable and sensitive-to-change measure among autistic adolescents receiving interventions (Laugeson et al., 2012; Shum et al., 2019). The Cronbach alpha for the TASSK at T0 was 0.85 in the current sample.

Social Responsiveness Scale (SRS). Parents rated the 65-item scale based on their observation of their adolescents' social impairment over the previous 3 months (Constantino, 2013). A higher score on this scale signifies a more significant social impairment. The Chinese version of SRS has been validated (Cen et al., 2017), and is sensitive to social capacity changes among autistic adolescents (Shum et al., 2019). The internal consistency measures for the SRS-2 total and subscales at T0 were good (all Cronbach alpha > 0.83).

Secondary Outcome Measures

UCLA Loneliness Scale 3 (UCLALS). The UCLALS is the most frequently used self-report loneliness scale in adolescent populations, with higher scores indicating higher levels of loneliness (Russell, 1996). Cronbach's alpha for the UCLALS at T0 in this study was 0.86.

Reflective Functioning Questionnaire 8 (RFQ8). Adolescents rated the items on a 7-point Likert scale. The 8-item RFQ8 comprises two dimensions, scilicet certainty (RFQc) and uncertainty (RFQu) concerning mental states. A mid-range score of RFQc /RFQu demonstrates a more optimum mentalizing. The reliability coefficients for the RFQc and RFQu at T0 were both 0.86.

Patient Health Questionnaire Anxiety and Depression Scale (PHQ-ADS). Adolescents rated how frequently depressive and anxiety symptoms had bothered them over the previous 2 weeks (Kroenke et al., 2016). A higher total score reflected more severe mood problems. Internal reliability for the PHQ-ADS at T0 was 0.86 in the current sample.

Liebowitz Social Anxiety Scale (LSAS). The LSAS is a self-rated measure assessing an individual's level of anxiety or avoidance across various social situations (Heimberg et al., 1999). The current study utilized the Fear subscale of LSAS, and the internal consistency for this sample at T0 was 0.86.

Rosenberg Self-esteem Scale (RSES). The RSES is a self-report scale covering global feelings of self-worth and self-acceptance (Rosenberg, 1965). A higher RSES total score indicates better self-esteem perception. The reliability coefficient of the RSES was 0.86 at T0.

Brief Problem Monitor-Parent Form (BPM-P). The 18-item BPM-P is a parent-report measure of adolescents' internal, external, and attention/hyperactivity problems

(Piper et al., 2014). The Cronbach alpha of the BMP-P total and subscales ranged from 0.83 to 0.85 at T0.

Additional outcomes were parents' emotional well-being (Patient Health Questionnaire 4 [PHQ4], Satisfaction with Life Scale [SWLS]. The Cronbach alpha of both scales at T0 were both 0.85) (Diener et al., 1985; Lowe et al., 2010) and parental competencies (Parental Competence Scale for Parents of Children with Autism [PCSA], the Cronbach alpha of the PCSA at T0 was 0.85) (Mohammadi et al., 2020).

Feasibility Measures

The feasibility of the PEERS® program was evaluated via the following measures: Attrition and attendance rates, the project-developed 4-item program satisfaction scale, and the Negative Effects Questionnaire (NEQ) for parents and adolescents. The NEQ is a 32-item instrument developed for monitoring and reporting the occurrences and magnitudes of negative effects during psychological interventions (Rozental et al., 2019). In this study, two bilingual translators translated the NEQ into Chinese and back-translated it into English (ZH, LU). Then the two English versions were compared for discrepancies and the Chinese version of the NEQ was further modified. The NEQ, completed by parents and adolescents, was adopted to quantify potential negative effects attributed to the training program.

For more detailed descriptions of the above measures, see Online Resource 3.

Statistical Analysis

All analyses were performed using Stata SP 16.0. Demographics, baseline, post-test, and feasibility variables were displayed in means (*SD*), median (*IQR*), or percentage (*%*) according to the data type and normality. Training effects of the primary outcomes applied the linear mixed effect model controlling for adolescents' gender, ages, and challenging behaviors (low and high challenging behaviors group divided by the median of BPM Total scores) at baseline (T0), with a random intercept for each participant using the assessment timeline as a fixed effect. The Bonferroni method was applied to account for multiple comparisons in regression models, with $p < 0.00357$ deemed significant ($= 0.05/14$). Effect size (EF) was reported as partial f^2 values (f^2: 0.02, 0.15, and 0.35 represent small, medium, and large effects) (Cohen, 2013). For the secondary and additional outcomes, baseline and post-test (T1) results were compared using the Student t-test. EF for group comparison was presented as Hedge's *g* (0.2, 0.5, 0.8 represent small, medium, and large effects) (Cohen, 2013). For all remaining analyses, we followed the convention with a *p*-value < 0.05 to indicate a statistically significant association.

Regarding the potential moderators for training efficacy, the median was used to divide parents' perceived school support into two categories (high [≥ 4] and low [< 4]). Primary outcomes with approaching medium to high EF in prior linear mixed-effect models would be further investigated for the moderating effect. In particular, linear mixed models with a random intercept for each participant utilizing the assessment timeline, groups defined by the level of perceived school support, and group x time interaction controlling for adolescents' age and gender as a fixed effect.

Baseline characteristics between adolescents with training effects to those without or with low training effects using primary outcomes (SRS Total scores and TASSK scores) were compared using the Student t-test. The criteria for high responders (HR) was defined as $\geq 30\%$ improvement on primary outcome measures, low responders (LR) as either worsened, no change, or $\leq 10\%$ improvement, and medium responders (MR) as 10-30% improvement. EF for group comparison was presented as Hedge's *g*.

Measures with medium to large EF in intervention-response group comparisons were considered to be potential independent variables for regressions. Before the simple linear regression analyses, Pearson correlation analyses were conducted between the outcome variables and the potential included variables, with $p < 0.1$ included in the following analyses.

Results

Participants' Characteristics

A total of 33 adolescents (Male: Female, 25:8, $M_{age} = 13.57$ (1.43)) participated in the study (Table 1), and one withdrew after two PEERS® sessions. The reason for attribution was overlapped time scheduling and traffic distances. All remaining 32 participating families completed the baseline questionnaires, while 28 (87.5%) parents and 23 (71.9%) adolescents completed the post-test questionnaires and program feedback questionnaires (Table 2).

Primary Outcomes

Application of the linear mixed model controlling for adolescents' gender, ages, and challenging behaviors at baseline (T0) indicated a significant change in TASSK scores (Mean differences: 4.42, *95%CI*: [3.16,-5.69]; Bonferonni, $p < 0.0001$, $EF = 0.42$). SRS Communication scores (Mean differences: -2.85, *95%CI*: [-4.90,-0.81]; Bonferonni, $p = 0.002$, $EF = 0.25$) and Total scores (Mean differences: -5.43, *95%CI*: [-10.84,-0.03]; Bonferonni, $p = 0.006$, $EF = 0.12$) decreased post-test though the latter did not past

Table 1 Participants' demographics at baseline (N = 33)

Variable	*M (SD)/n (%)*	[Min-Max]
Age (y)	13.57 (1.43)	[11.02–17.32]
Gender (m:f)	25:8	-
Intelligence Quotient		
Full Scale	97.06 (17.04)	[68,138]
Verbal	101.28 (17.83)	[75,144]
Mother's age (y)	42.04 (3.19)	[36.86,50.97]
Father's age (y)	44.97 (4.76)	[35.69,58.20]
Parent's education level[a]		
Mother	2:1:6:17:6	-
Father	0:2:4:16:10	-
Family annual income (in thousands CNY[b], 60–80: 80–100: >100)	2:1:29	-
Both parents involved in the training program	20 (62.5%)	-
Gender ratio in families with only one parent involved in the program (m:f)	3:8	-
Disclosure of the diagnosis to the school	23 (76.7%)	-
Parents' perceived support from school	4.03 (2.54)	[1–9]
Co-occurring Conditions		
Attention-deficit/hyperactivity disorder	9 (28.1%)	-
Tics	3 (9.4%)	-
Epilepsy	1 (3.1%)	-
Childhood emotional disorder, unspecified	6 (18.8%)	-

a: Education level was defined as five levels, namely junior high school or below, senior high school or vocational school, college, bachelor, and master or above.

b: CNY: Chinese Yuan.

the multiple comparison corrections significant threshold. No other primary outcomes changed significantly between baseline and post-test (Table 3; Fig. 1).

Secondary Outcomes

Adolescents' self-esteem was boosted post-intervention as measured by RSES ($p = 0.04$, EF = -0.48) (Table 2). Other secondary measures showed no significant difference post-test, though PHQ-ADS was close to being statistically meaningful ($p = 0.05$, EF = 0.46).

Feasibility Results

Among the 32 adolescents who completed the intervention (retention rate: 97%), 84% had attended at least 11 of the 14 training sessions ($n = 27$).

Participants generally considered the content of PEERS® to be comprehensible (Fig. 2). Moreover, most participants regarded PEERS® as a program relevant to their needs, involving practical content, and meeting their anticipations modestly. Remarkably, adolescents' opinions were more varied than that of parents. In particular, two adolescents with relatively lower FSIQ (82 & 75) considered the program rather challenging to understand, and one rated the program as inapplicable and irrelevant.

Of 28 parents that responded to the feedback questionnaire, three reported at least one negative event (11%). Negative effects attributed to PEERS® program were mainly related to novel psychological symptoms, followed by deficiencies in the program, hopelessness, and feelings of incompetence (Table 4 & Online Resource 4). The magnitudes of these negative effects ranged from mild to moderate. On the other hand, 3 in 23 adolescents reported having at least one negative event after participating in the program (13%). The negative effects reported by adolescents consisted of novel psychological symptoms, hopelessness, stigma, and insufficient quality of the program. Notably, one participant reported having extremely strong suicidal thoughts after participating in the program. The remaining negative impacts ranged from "not at all" to "moderately". Although some parents and adolescents reported that they developed dependencies on the program and trainers, none considered the dependencies directly related to the program.

Regarding an open-end question on other negative effects not addressed by the NEQ, six parents reported they lacked adequate competencies to facilitate their adolescents completing the homework. On the other hand, two parents felt frustrated with their child's non-compliance. One adolescent and her parent both considered her emotional difficulties not improved. Finally, one parent expressed concerns about the negative effect of the telehealth session. The open-end question unveiled no other new theme.

Adolescent and Parent Factors Affecting the Effectiveness of the Intervention

The parent-perceived support from school was divided into the high support (HS) or low support (LS) group using the median of 4 (HS number = 14, LS number = 15). The group by time interaction controlling for adolescents' age, gender, and challenging behaviors at T0 revealed a more significant decrease in SRS Communication scores (Group difference = -3.99, *95%CI*: [-7.68, -0.29]; Bonferonni, $p = 0.0002$, EF = 0.21) and SRS Total scores (Group difference = -12.26, *95%CI*: [-23.35, -1.16]; Bonferonni, $p = 0.001$, EF = 0.18) for the HS group post-intervention with a medium EF (Table 5; Fig. 3).

Table 2 Pre- and post-intervention outcomes of adolescents' and parents' measures

Variables	n_{T0}	T0		n_{T1}	T1		*Z*	*P*[c]	*Hedges' g*
		M (SD)/ Median (IQR)	*[Min-Max]*		*M (SD)/ Median (IQR)*	*[Min-Max]*			
Adolescents' measures									
TASSK	32	11.75 (2.13)	[7–16]	23	16.04 (3.05)	[9–20]	-6.16	**< 0.0001**	-1.66
SRS	32			28					
Total		88.78 (16.95)	[46–128]		82.86 (19.60)	[36–134]	1.26	0.11	0.32
Communication		30.22 (7.29)	[12–47]		27.17 (7.84)	[10–42]	1.57	0.06	0.40
Awareness[a]		8 (6–9)	[6–16]		9 (6.5-9)	[4–13]	0.27	0.40	0.07
Cognition		17.69 (3.68)	[8–24]		16.41 (3.66)	[9–23]	1.35	0.09	0.34
Motivation[a]		34 (30–37)	[24–41]		32.5 (31.5–35)	[28–45]	0.58	0.28	0.15
Mannerism		16.23 (5.23)	[7–26]		15.25 (5.27)	[6–31]	0.58	0.28	0.15
PHQ-ADS[a]	32	6.5 (3–17)	[0–28]	23	2 (0–11)	[0–34]	1.64	0.05	0.46
LSAS-Fear Score	32	45.28 (14.93)	[24–82]	23	43.61 (14.22)	[24–74]	0.42	0.34	0.11
UCLALS3	32	49.16 (6.23)	[33–60]	23	47.52 (7.88)	[29–63]	0.86	0.20	0.23
RSES	32	31.23 (8.26)	[12–48]	23	34.95 (6.89)	[22–50]	-1.73	**0.04**	-0.48
RFQ8	32			23					
RFQc		0.88 (0.74)	[0-2.5]		1.07 (1.00)	[0–3]	-0.84	0.20	-0.23
RFQu[b]		0.6 (0.4–0.9)	[0–3]		0.60 (0–1)	[0-1.8]	-1.16	0.13	-0.31
BPMP	32			28					
Attention		6.53 (2.57)	[1–12]		6.61 (2.54)	[2–11]	-0.11	0.45	-0.03
Internal		4.38 (2.35)	[1–9]		4.14 (3.29)	[0–12]	0.32	0.38	0.08
External		5.72 (2.75)	[1–11]		5.57 (2.92)	[1–13]	0.20	0.42	0.05
Total		16.63 (6.40)	[4–26]		16.32 (7.46)	[3–36]	0.17	0.43	0.04
Parents' measures									
PHQ4[a]	32	2 (0–4)	[0–11]	28	1.5 (0–4)	[0–11]	-0.44	0.33	-0.11
SWLS	32	19.16 (5.44)	[5–31]	28	18.29 (6.58)	[6–28]	0.56	0.29	0.14
PCSA	32	57.09 (9.23)	[36–75]	28	60.43 (9.84)	[39–83]	-1.35	0.09	-0.35

BPMP brief problem monitor-parent form, *LSAS* Liebowitz social anxiety scale, *PCSA* parental competence scale for parents of children with autism, *PHQ4* patient health questionnaire, *PHQ-ADS* patient health questionnaire anxiety and depression scale, *RFQ8* reflective functioning questionnaire 8, *RFQc* RFQ certainty, *RFQu* RFQ uncertainty, *RSES* Rosenberg self-esteem scale, *SRS* social responsiveness scale, *TASSK* test of adolescent social skills knowledge, *UCLALS* UCLA loneliness scale, *SWLS* satisfaction with life scale

a: Variable met Normal distribution after squared-root transformation. The variable was presented as median(IQR).

b: Variable met Normal distribution after reverse squared-root transformation. The variable was presented as median (IQR).

c: $P < 0.05$ were marked bolded.

Table 3 Adjusted mixed effect regression for the primary outcome

	B (SE)	*z*	*P > z*	*95%CI*	*Wald* X^2	*P*	f^2
SRS[a]							
Awareness	-0.44 (0.39)	-1.14	0.25	[-1.20, 0.32]	1.62	0.81	0.04
Cognition	-1.17 (0.64)	-1.81	0.07	[-2.43, 0.10]	7.60	0.11	0.09
Communication	-2.85 (1.04)	-2.73	0.006	[-4.90,-0.81]	16.76	**0.002**	0.25
Mannerism	-0.71 (0.79)	-0.90	0.37	[-2.26, 0.83]	11.40	0.02	0.02
Motivation[b]	-0.07 (0.10)	-0.74	0.46	[-0.27, 0.12]	12.76	0.01	0.00
Total	-5.43 (2.76)	-1.97	0.049	[-10.84,-0.03]	14.62	0.006	0.12
TASSK[c]	4.42 (0.64)	6.87	< 0.0001	[3.16, 5.69]	49.22	**< 0.0001**	0.42

SRS social responsiveness scale, *TASSK* test of adolescent social skills knowledge

Models adjusted for adolescents' gender, age, and challenging behaviors at baseline. *P*-values of regression models smaller than 0.00357 were marked in bolded.

a: Number of groups = 32, number of observations = 61.

b: Square-root transformation had been made to meet the normal distribution.

c: Number of groups = 31, number of observations = 55.

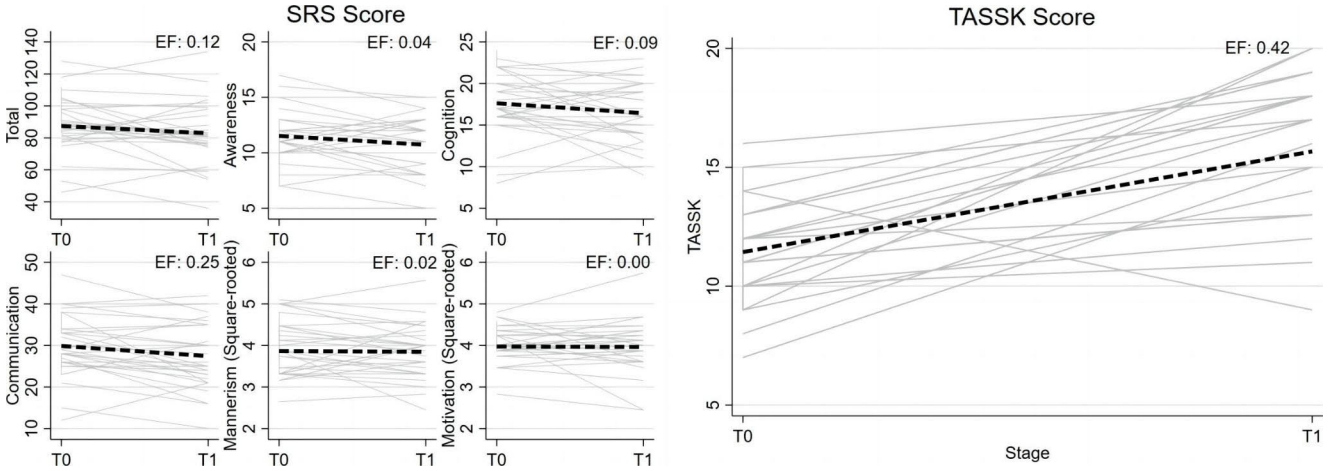

Fig. 1 Spaghetti plots of the primary outcomes with predicted means. Full lines in light color: Individual's change; Thick dotted lines in dark color: Predicted means of the outcomes (EF: Effect size; SRS: Social responsiveness scale; TASSK: Test of adolescent social skills knowledge)

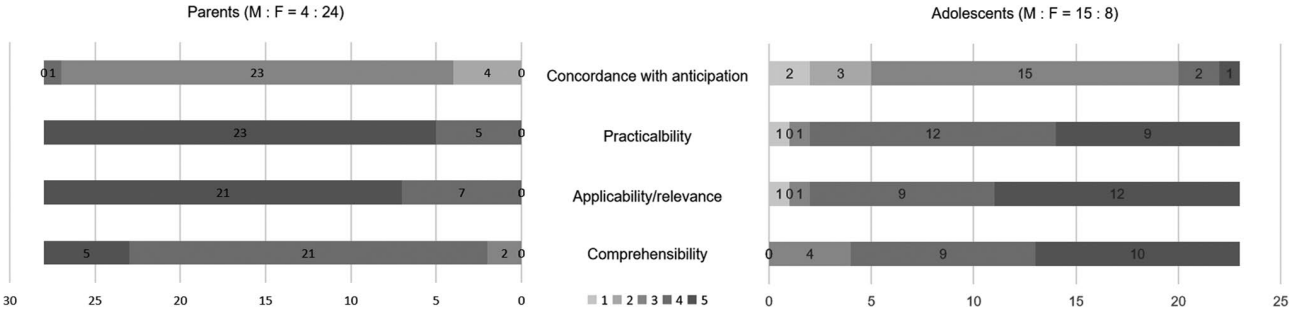

Fig. 2 Program feasibility questions stacked graph. (From Level 1–5, with higher level indicated stronger agreement or difficulty). The numbers in the graph represent the number of people who rated at a specific level

Table 4 Negative effects attributed to the PEERS® program

	n	Parents (*N* = 28)		Adolescents (*N* = 23)			
		Each domain count	Frequency (%)	Each domain count	Frequency (%)	X^2	*P*
Symptoms	10	280	9(3.21%)	230	3(1.30%)	1.92	0.17
Insufficient quality	11	308	3(0.97%)	253	8(3.16%)	3.32	0.07
Dependency	2	56	0	46	0	-	-
Stigma	2	56	0	46	3(6.52%)	3.53	0.06
Hopelessness	4	112	1(0.89%)	92	3(3.26%)	1.41	0.23
Failure	3	84	0	69	0	-	-
Total	32	896	13(1.45%)	736	17(1.90%)	1.59	0.21
Total number of people reporting negative events	-	-	3(11%)	-	3(13%)	-	-

Each domain count was calculated by multiplying the total number of respondents (*N*) by the number of items per domain (*n*) (*N* x *n*).

On the other hand, as shown by the exploratory linear regression analysis, the increment scores of TASSK were negatively associated with parents' subjective well-being, with parents feeling more distressed at baseline predicted more improved social skills knowledge (Mean difference = -0.35, *95%CI*: [-0.57,-0.14], Bonferonni, $p = 0.0025$, EF = 0.36). No other exploratory regression results were significant (Online Resource 5).

Finally, the baseline outcome measures between intervention-responder groups were compared (Online Resources 6 & 7). The results of the SRS Total scores intervention-responder group comparison indicated no significant difference between the LR and MR/HR groups. On the other hand, a comparison between the LR/MR and HR group of TASSK scores revealed that parents of the HR group were more distressed at baseline, as shown by lower parents' self-report subjective-welling score (LR/MR vs. HR, SWLS Mean difference: 6.34, *95%CI*: [1.17, 10.62], $p = 0.009$, EF = 1.07).

Table 5 The moderating effect of parents' perceived support from school between outcome and time stage

Dependant variable	*N* of Obs.	T1 × High perceived support from the school				Model significance		Interaction variable
		B (SE)	*z*	*P* > *z*	*95%CI*	*Wald* X^2	*P*	f^2
Unadjusted models								
SRS Communication	56	-4.01 (1.88)	-2.13	0.03	[-7.70, -0.32]	14.78	**0.002**	0.21
SRS Total	56	-12.36 (5.66)	-2.18	0.03	[-23.46, -1.27]	8.72	0.03	0.20
TASSK	49	-0.54 (1.53)	-0.35	0.73	[-3.52, 2.45]	37.83	**< 0.0001**	0
Adjusted models[a]								
SRS Communication	56	-3.99 (1.88)	-2.12	0.03	[-7.68, -0.29]	26.35	**0.0002**	0.21
SRS Total	56	-12.26 (5.66)	-2.17	0.03	[-23.35, -1.16]	21.78	**0.001**	0.18

Obs. Observations, *SRS* social responsiveness scale, *TASSK* test of adolescent social skills knowledge

P-values of regression models smaller than 0.00357 were marked in bolded.

a: Adjusted for adolescent's age, gender, and challenging behaviors at baseline.

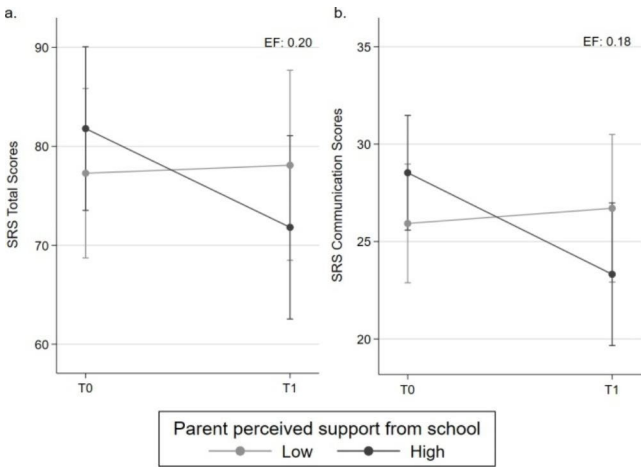

Fig. 3 The moderating effect of parents' perceived support from the school. (**a**) SRS total scores change predicted by stage. (**b**) SRS Communication scores predicted by stage. Light color: High support group (n = 14); Deep color: Low Support group (n = 15) (EF: Effect size; SRS: Social responsiveness scale)

Discussion

The present study systematically assessed the feasibility and cross-cultural validity of the Mandarin version of PEERS® in the Mainland China context. In addition, this study investigated the potential negative effects of PEERS® and the potential moderating factors influencing the effectiveness of PEERS®.

Cultural Adaption

To make the evidence-based intervention program PEERS® valid and accessible for autistic adolescents speaking Mandarin, several minor but important adaptions were made to accommodate the Chinese clinical settings (Online Resource 2). In terms of delivery format, we extended the parent-adolescent reunion component, provided each parent with a summary and recommendations about their adolescent's performance during the session, applied visual cues to reinforce classroom rules and reward points, and adopted a hybrid class format to incorporate real-world situations. In terms of content, we selected and modified games and activities, terms, and terminologies that were culturally and linguistically appropriate for the local area. These adaptations, nevertheless, are not included in the currently published Chinese version of the PEERS® manual (Laugeson & Frankel, 2010a, b/2020).

Preliminary Efficacy

The overall findings suggested that with minor cultural modifications, PEERS® might be efficacious in facilitating the improvement of social etiquette knowledge, reciprocal communication, and self-assertiveness among Chinese autistic adolescents with IQ above 70. The results were identical to the reports of previously published studies on PEERS® (Gilmore et al., 2022). On the other hand, the overall autistic traits, albeit decreasing trend, and other SRS Domain scores, except for reciprocal communication abilities, did not indicate significant training effects at initial analyses (all with small EF, see Table 3; Fig. 1). Previous findings of the efficacy of the PEERS® study on Japanese culture suggested that a significant decrease in SRS-2 scores was shown only within the pre- and follow-up-test but not pre- and post-test (Yamada et al., 2020). Hence, the development of adaptive social responsiveness might be gradual instead of immediate.

Feasibility

The present study showed that PEERS® was considered acceptable, appropriate, and practical by most parents and adolescents. The high retention rate (97%) and compliance rate (84%) demonstrated that the adapted Mandarin version of PEERS® is likely to be feasible among Mandarin-speaking Chinese adolescents on the autism spectrum. Especially, two PEERS® groups in our study also included some sessions delivered online due to COVID-19. It is encouraging

that the overall feedback from the hybrid groups did not reveal telehealth sessions to be unsatisfactory. Also inspiringly, recent preliminary reports on PEERS® on adolescents via both blended and telehealth delivery demonstrated that telehealth delivery has comparable efficacy to in-person delivery (Estabillo et al., 2022; Wolstencroft et al., 2021). Future studies on SSGT may propose more delivery methods and compare their effectiveness, especially validating the efficacious of and taking advantage of telehealth technologies.

Noticeably, a nonnegligible portion of parents reported not having sufficient coaching skills to facilitate their adolescents' practicing social skills (6/28, 21.4%). Even though we had augmented tutoring in social coaching techniques for parents, the feedback implies that Chinese parents still need more support in applying to construct advising.

Interestingly, results from the program satisfaction scale revealed that parents and adolescents' views varied, particularly regarding the concordance of anticipation and comprehensibility. While most parents were highly satisfied with the course, approaching 1/5 of adolescents considered that the program's content only moderately met their anticipations (scored a 3) and was rather too simple (scored either a 2 or 1). This finding contends that a more homogeneous group may facilitate more favorable outcomes, possibly because trainers can more readily tailor the content to meet the needs of different members within a group. Also, noticing the divergent opinions between parents and adolescents, it is critical to probe into the perspectives of adolescents when forming a social skills training group.

To our best knowledge, the current study is the first to probe into the potential harms of PEERS® quantitatively. Our results confirm PEERS® as a beneficial program with few negative effects. Nonetheless, a small portion of parents and adolescents felt more stressed or depressed post-intervention (Table 4 & Online Resource 4). Those who reported elevating distress were either parents of adolescents having more remarkable autistic traits or with more significant autistic traits and psychological symptoms. A recently published study pointed out that participants with more significant autistic traits before training might be less beneficial to the training effects (Dekker et al., 2021). Our results are, to a certain extent, analogous to the conclusion of this study. Our results connote that participants with more significant autistic traits before the training may need more personalized support, including but not limited to methods of alleviating distresses and reducing affiliated stigma. They may also benefit from strategies targeting emotional regulation.

Although the feasibility outcomes suggested that implementing the adapted Mandarin version of PEERS® is likely to be feasible, the adolescents' self-report outcome data collection procedure applied in this study may need further refinement in future trials. In particular, the relatively unsuccessful attempt to recover adolescent-reported questionnaires online during the post-test period (non-response rate 28.1%) suggested that parents might be more cooperative in completing online questionnaires while filling in the questionnaires on the spot might be a more suitable option for adolescents.

Potential Moderators

The moderator investigation of the perceived school support level indicated that adolescents with a higher level of parents' perceived support from schools significantly improved social communication and decreased overall autistic traits (both with medium EF, see Table 5; Fig. 2). School support is one of the fundamental factors for aiding successful outcomes in autistic individuals and facilitating family health (Hasson et al., 2022). Although the majority of autistic adolescents in China are being educated in mainstream classrooms, inclusion is at large inadequate, and stigmatization is common (Clark et al., 2019; Yu et al., 2020). Social skills improvement in autistic adolescents will not function to maximum if stigmatization encompassing ignorance, prejudice, and discrimination is highly prevalent (Lüddeckens, 2021). Therefore, future investigations on SSGT effectiveness should take a closer look at the impact on schools.

We also investigated the differences in clinical characteristics between the intervention-response and the no-response group. Results indicated that adolescents with better reflective functioning (RF) at baseline would be more likely to benefit from the PEERS®. An uncertain RF style is characterized by individuals who are intolerant of alternative perspectives and have inflexible mental states, often disassociated from reality (hypo-mentalizing) (Fonagy et al., 2016). Assimilating knowledge of social etiquette requires adolescents to be more open-minded and accept perspectives different from their past practices. Hence, a high uncertainty of RF may eventually lead to a lower training effect reflected by the social knowledge improvement and the reduction of autistic trait burden (Online Resources 6 & 7). Concisely, the results of this study on RF provide prima facie evidence of the characteristics of autistic adolescents that may be more beneficial from the PEERS®.

One surprising finding in this study was that parents with less satisfied subjective welling before intervention might be associated with more remarkable improvement in adolescents' social skills knowledge after the intervention (Online Resource 5). Parents of children with more significant autistic traits often reported higher magnitudes of psychological distress (Li et al., 2022). A trial focused on substance use and risky sexual behaviors prevention among high-risk

adolescents reported resembling findings (Ng et al., 2020). In particular, that study found that the training effect of parent-involved intervention outperformed that of adolescent-only intervention when parents' self-reported distress at baseline was high. The underlying reason for this interesting finding might be more distressed parents would be more engaged in facilitating their adolescents' intervention. The present results suggest that adolescents with more distressed parents (parents with higher intervention demand) would be more likely to benefit from higher-intensity parental engagement interventions. Nonetheless, the present study did not directly investigate the relationship between parental involvement during the PEERS® program and intervention outcome. Future studies should pay more attention to the underlying significance of these factors.

Limitations

The small sample size, the preset stringent α level, and the uncontrolled single-group design nature of this study would warrant a humble interpretation of the results. Another limitation of this study was the relatively high no-response rate of post-intervention within the adolescent questionnaires (28.1%). The high no-response rate would limit the interpretation of the results. However, the credibility of the current findings will improve due to establishing a strict significance level, albeit with reduced power of the statistical tests. Considering the current feasibility study served mainly to test the preliminary effects of the Mandarin version of PEERS®, the current results may best regard as providing initial parameter estimates for future full-scale RCT sample size calculation (Sim, 2019). In addition, we contend that future full-scale research could reduce the number of secondary outcome measures and conduct power analyses to determine an adequate sample size.

Furthermore, the present study did not collect quantitative data on intervention integrity. The lack of quantifiable data would make it impossible to ensure the internal validity of the intervention fully. Nevertheless, intervention fidelity would be ensured by conducting regular trainers' supervision, holding trainers' group meetings before and after each session, and translating and manualizing the teaching materials. Also, the low attrition rate ($n = 1$) and the generally positive reports from both adolescents and their parents, including the dosage of intervention (i.e., attendance rate), program feasibility questionnaire, and the NEQ, supported the successful implementation of the intervention. Lastly, the present study did not include a follow-up assessment and did not include a comparison group, limiting the generalization of the findings into mid-term and long-term effects on Chinese autistic adolescents without intellectual disabilities.

Overall, this feasibility study resulted in the finalization of Mandarin PEERS®. This study also provides preliminary efficacy and potential moderating factors of PEERS®. Results suggest that the PEERS® is appropriate and practical for Chinese adolescents on the autism spectrum while highlighting the importance of cultures and individualized intervention.

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Author Contributions Conceptualization and design of the study were undertaken by LU and ZH. LU, ZH, and WY designed the online questionnaires. WY, XY, HX, LYM, and ZX assisted with the administration of groups and offer clinical support. Measures used were selected by LU, ZH, WY, LY, and BW. Analyses were undertaken by LU, ZH, LY, and XY. Drafting of the manuscript was undertaken by LU with input from ZH, LY, BW, LYM, XY, HX, and ZX. LU and ZH revised the manuscript. All authors contributed to, read, and approved the final manuscript.

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Data Availability The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Conflict of Interest All authors declare that they have no conflicts of interest.

Consent Following the intake interview, informed consent forms would be obtained if the participants met the criteria.

Ethics Approval Ethical approval for this study was provided by the Medical Ethics Committee of the Third Affiliated Hospital of Sun Yat-sen University ([2019]02-013-01 and [2021]02-337-01).

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