Original Article

Assessment of the effectiveness of parent-targeted interventions for the use of child restraint systems: a systematic review and meta-analysis

Ya-Ru Sun[1], Ting Liu[1], Ni Ran[2], Jun-Yu Chen[3], Yu-Shuo Niu[4], Xin Wang[1], Ying Luo[1], Ming-Qin Lu[1], Xiu-Ling Yang[1]

[1]Department of Nursing, School of Nursing, Qingdao University, Qingdao, China; [2]Department of Child Prevention and Health Care, The Affiliated Hospital of Qingdao University, Qingdao, China; [3]Department of Cardiovascular Surgery, The Affiliated Hospital of Qingdao University, Qingdao University, Qingdao, China; [4]Department of Hepatobiliary Surgery, Provincial Hospital Affiliated to Shandong First Medical University, Qingdao, China

Contributions: (I) Conception and design: YR Sun, XL Yang; (II) Administrative support: XL Yang; (III) Provision of study materials or patients: T Liu, N Ran, JY Chen; (IV) Collection and assembly of data: YR Sun, YS Niu, X Wang; (V) Data analysis and interpretation: YR Sun, T Liu, MQ Lu, Y Luo; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Xiu-Ling Yang, PhD. School of Nursing, Qingdao University, No. 38 Dengzhou Road, Shibei District, Qingdao, 266000, China. Email: ratyxl2003@163.com.

Background: It is essential to implement parent-targeted interventions to increase the use of child restraint systems (CRS) and thus reduce the injuries and deaths of children due to motor vehicle collisions. To optimize future intervention designs, this meta-analysis sought to quantify the effects of parent-targeted interventions and explore potential intervention moderators.

Methods: Studies met inclusion criteria if they included a parents-targeted intervention that focused on increasing CRS use for children, published from the inception of the databases to January 2022, were systematically retrieved from the PubMed, Embase, Cochrane library, Web of Science, Sinomed, Wanfang, and CNKI databases. Next, 2 researchers independently screened the retrieved articles, evaluated their quality according to the Cochrane Tool, and extracted the data. Finally, Stata12.0 was used for the meta-analysis. Heterogeneity was examined with I^2, stratified analyses, and meta-regression.

Results: Of the 1,690 articles retrieved, 9 studies, comprising 22,329 parents of children aged 0–12 years, were ultimately included in the analysis. The results of the meta-analysis showed that the CRS use rate of the intervention group was 1.62 times higher than that of the control group [95% confidence interval (CI): 1.25–2.11, Z=3.616, P<0.001], indicating the positive effect of parent-targeted interventions on promoting the use of CRS. The subgroup analysis found that interventions guided by behavioral theories increased the use of CRS (odds ratio: 1.44, 95% CI: 1.27–1.63, n=5). The difference in the use of CRS between the groups in the studies that were not guided by theories was not statistically significant, indicating that interventions guided by behavioral theories may be the source of the heterogeneity. Risk of bias was low in most studies.

Conclusions: It is necessary to conduct interventions with parents to increase the use of CRS. The effects on CRS use appear to differ depending on whether the interventions are guided by behavioral theories. In-depth research needs to be conducted to explore the characteristics of the interventions, especially those guided by different behavioral theories, to reduce child vehicle injuries.

Keywords: Parenting; injury prevention; meta-analysis; child restraint systems (CRS)

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Introduction

Road traffic injuries to children are a public health problem worldwide (1). Each year, 180,000 children are killed in road traffic accidents worldwide, which results in a loss of 3% of gross domestic product in most nations and imposes a heavy medical burden on nations all over the world (2). Despite the seriousness of the child passenger safety problem, previous studies have shown that most road traffic injuries and deaths are preventable (3,4). Following the introduction of child restraint systems (CRS) and child occupant protection laws, the number of deaths of child occupants from motor vehicles accidents decreased from 10.5 to 3.2 per 100,000 children between 1970 and 2007 (5,6).

Child restraint laws are considered the most powerful intervention for increasing the use of CRS; however, these measures require strong enforcement by the government and a degree of punishment to achieve the desired results (7). The best way to increase the use of CRS is to change parents' perceptions and attitudes towards the use of CRS (8). Due to immaturities in children's physical and mental development and inadequacies in their self-judgment and ability to self-protect, parents are the main guardians of children's safety (9,10). However, studies suggest that the rate of CRS use is extremely low due to a lack of parents' knowledge about CRS use, and poor safety-related beliefs and awareness of child passengers (11-15). Thus, the identification of effective strategies of parent-targeted interventions to prevent road traffic injuries is of great significance to children's health worldwide.

In the last decade, numerous studies examining the efficacy of the increased use of CRS have been published (16-18). A systematic review of the increased use of CRS suggested that different approaches to CRS interventions could be effective in increasing parents' awareness and knowledge of CRS. However, it is unclear which method is most effective for parents (19). Several methodological issues may have affected the validity of the results of previous studies, including design features (e.g., study design) and intervention characteristics (e.g., the intervention setting), which might moderate the intervention effects (20). Evidence suggests that multicomponent interventions tailored to different communities can improve the use of CRS (21). However, those studies target only focused on community children, and thus the generalizability of the results to the general population are unclear.

Accordingly, an updated and thorough examination of previous research on interventions seeking to increase parents' CRS use and their effective components is necessary to provide information for future designs. The study sought to quantify the effects of parent-targeted CRS interventions and explore potential intervention moderators. We present the following article in accordance with the PRISMA reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-22-560/rc).

Highlight box

Key findings

- Intervention based on theory guidance is the effective way to improve parents' use of CRS.

What is known and what is new?

- Parent-targeted interventions can increase the use of CRS.
- The effects on CRS use appear to differ depending on whether the interventions are guided by behavioral theories.

What is the implication, and what should change now?

- Intervention guided by theory should be increased to better increase the use of CRS.

Methods

Search strategy

The PubMed, EMBASE, Cochrane library, Web of Science, SinoMed, Wanfang, CNKI were searched to retrieve relevant articles. Specific retrieval strategies were formulated for the respective databases. A combination of subject terms and free words were used for the retrieval. The search was limited to studies on parents of children aged 0–12 years, and the search languages were limited to English and Chinese without any restriction in relation to publication status. All references in the included studies were also reviewed to prevent the omission of other potential eligible studies. For further details on the search terms and the results, see the Appendix 1 search query.

Inclusion and exclusion criteria

Primary studies were included in the meta-analysis if they met the following inclusion criteria: (I) If the studies included a parents-targeted intervention that focused on increasing CRS use for children; (II) primarily targeted the parents of children aged 0–12 years; (III) Studies report the use of CRS before and after the intervention; and (IV) were published in Chinese or English. If the published studies

did not include adequate data for calculating the effect size, the corresponding authors were contacted twice and asked to provide additional information.

Studies were excluded from the meta-analysis if they met any of the following exclusion criteria: (I) were repeated publication; and/or (II) comprised a summary, comment or minutes of meetings. Table S1 sets out the definitions for the interventions/exposure and outcomes.

Screening of studies and data extraction

The articles in the databases were searched, screened and cross-checked by the 2 researchers independently. Any disagreement was resolved via discussion with a 3rd researcher. In the article screening, all the studies were imported into Endnote reference manager software to delete duplications. The 2 reviewers then independently screened all the titles and abstracts to examine the relevance of each article based on the inclusion and exclusion criteria. Full-text versions of the identified studies, including the reference sections, were carefully read to select the relevant original studies that met the inclusion criteria.

The 2 researchers extracted the data independently. The data items included the first author, report and study information (e.g., publication year, study region, and design), sample characteristics (e.g., age), methods and design (e.g., control group), intervention characteristics (e.g., the intervention setting), and outcome data (e.g., the sample size and effect size). Any inconsistencies that arose between the 2 researchers in terms of the data extraction were discussed with a 3rd researcher until a consensus was reached.

Quality appraisal and risk of bias assessment

The 2 researchers independently evaluated the risk of bias of the included articles according to the Cochrane Tool and cross-checked the results and each study was evaluated according to "low risk", "high risk", and "uncertain". The criterion included random-sequence generation, assignment concealment, subject and staff blinding, outcome evaluation blinding, incomplete outcome data, selective reporting, group similarity at baseline, compliance, intention-to-treat analysis, and timing of outcome evaluation. If a study does not report a method, it is classified as an uncertain risk. Any disagreements on the risk of bias and quality of the evidence were resolved through discussion among the 3 researchers until a consensus was reached.

Statistical analysis

A random-effects meta-analysis using the DerSimonian and Laird method was conducted to determine the association between parent-targeted interventions and the use of CRS. A combined odds ratio (OR) estimate was obtained using fixed- and random-effects models. In the presence of heterogeneity (I^2>50% or a chi-square P value <0.05), the random-effects model was used. Potential sources of heterogeneity were assessed by meta-regression (the metareg command in Stata). All the analyses were conducted using Stata, version 12.0 with 2-tailed α value of 0.05.

Results

Literature search

The process of the systematic literature search is presented in *Figure 1*. Of the 1,690 studies identified in the database and reference searches, 892 duplicate articles were excluded. After the title and abstracts of the remaining studies were screened, 73 potentially relevant studies remained. After the full-texts of the articles were read, 25 articles were excluded as they did not meet the inclusion criteria, 18 studies with non-standard or unreported outcome indicators were excluded, and 21 studies without baseline measurement data were excluded. Ultimately, 9 studies were included in the meta-analysis.

Summary of the enrolled studies

Pooled estimates for the 9 included studies were calculated (16,22-29). Table S2 lists the basic information and quality evaluation results of the studies. The data of the original intervention studies in China and abroad on parents of children aged 0–12 years were collected and the quality of these studies was strictly evaluated. Ultimately, 22,329 cases were included in the meta-analysis. The 9 studies were mainly conducted in Europe, Asia, and America. The publication dates ranged from 2011 to 2020, and 56% of the studies had been published in the last 5 years. There were 4 medium-quality studies and 5 high-quality studies. All the included studies related to research targeting parental interventions to increase CRS use, and excluded other types of child caregivers. The interventions were implemented at diverse sites. Specifically, 5 interventions were implemented at hospitals (22,24-26,29), 2 in communities (27,28), and 2 at child education centers (16,23). Among the studies, 5 of the interventions were

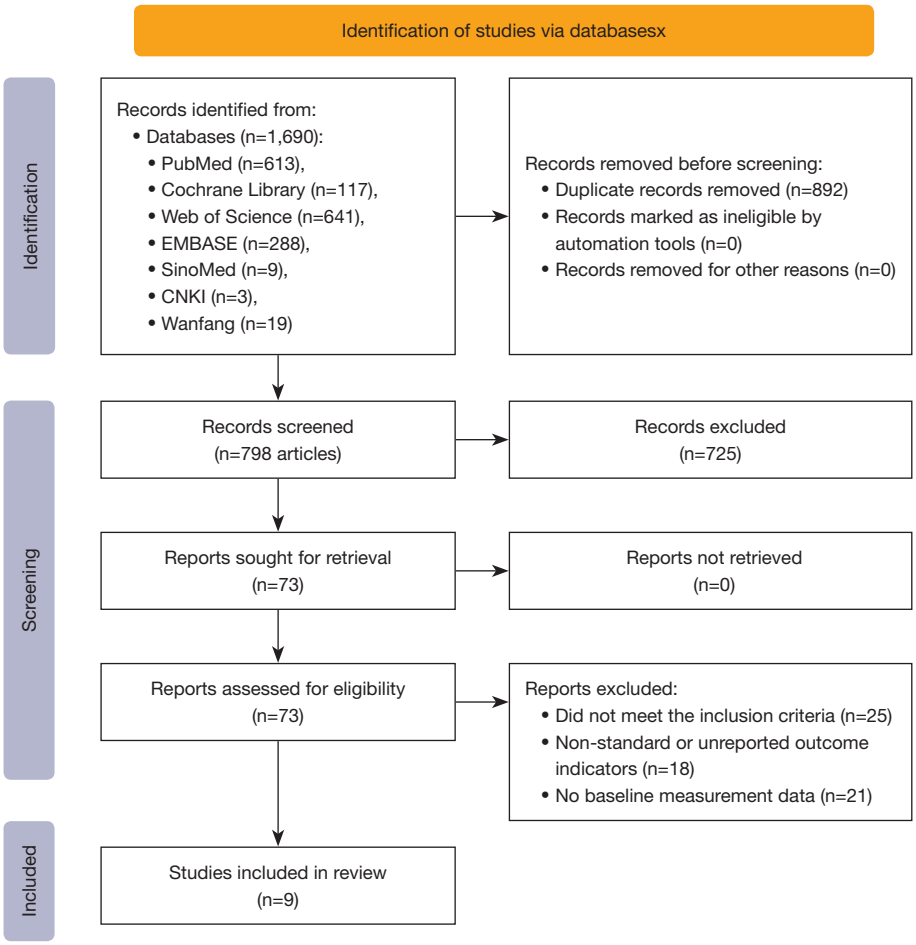

Figure 1 Flowchart of search and screening process.

guided by behavioral theories, and 4 did not report on whether a theory or framework had been used. The most frequently used theory/framework was the Precaution Adoption Process Model. The interventions included general health education interventions (n=5), and computer-based mobile communication technology interventions (n=4).

Intervention effects

A meta-analysis was conducted of the included articles, and the results revealed heterogeneity among the studies (I^2=81%). The random-effects model was used to conduct the meta-analysis. As *Figure 2* shows, after the use of the intervention measures, the CRS use rate of the intervention group was 1.62 times higher than that of the control group [OR: 1.62, 95% confidence interval (CI): 1.25–2.11, Z=3.616, P<0.001], indicating that parent-targeted interventions increased the use of CRS. Table S3 shows the effect estimate and its precision.

Analysis of sources of heterogeneity

Meta-regression and subgroup analyses were used to investigate the potential sources of heterogeneity among the studies. For analytical purposes, the characteristics of the studies were grouped as follows: intervention site setting (community, hospital, or child education center), interventions guided by a behavioral theory (yes/no), and intervention tools (virtual/technological platforms or general education interventions).

The results of the subgroup analysis of the intervention site settings indicated that the heterogeneity of the 3 groups was low (community: I^2=0%, child education center: I^2=0%, and hospital: I^2=41%). Interventions at communities, child

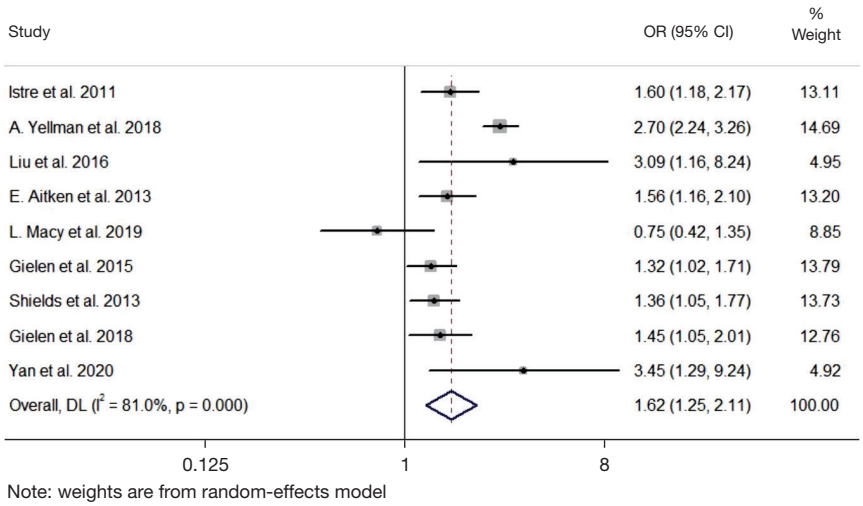

Figure 2 Forest plots of the results from the meta-analysis. CI, confidence interval; OR, odds ratio.

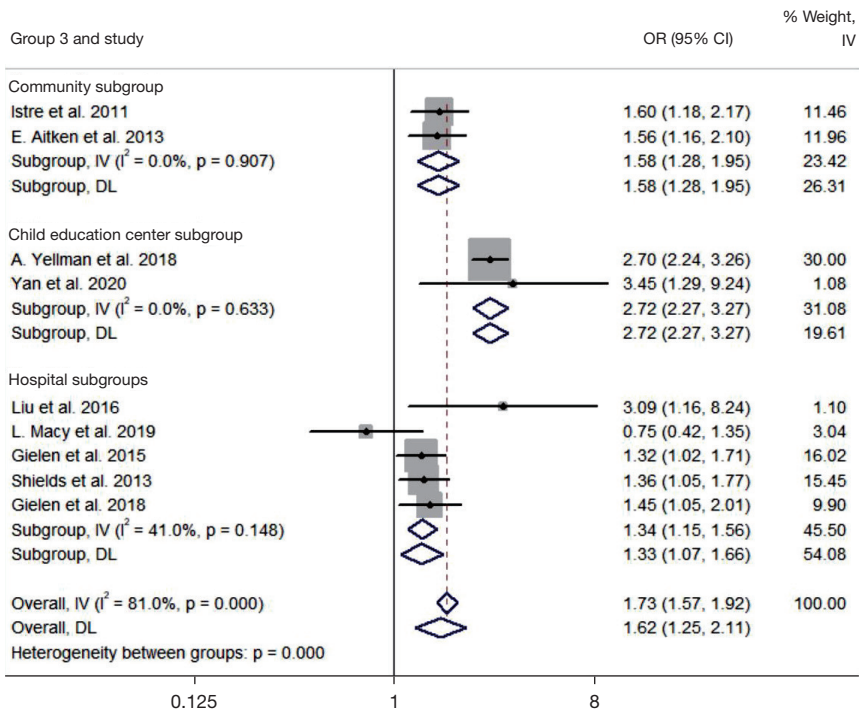

Figure 3 Subgroup analysis of the intervention sites. CI, confidence interval; OR, odds ratio.

education centers, and hospitals all increased the use of CRS (community: OR: 1.58, 95% CI: 1.28–1.95; child education center: OR: 2.72, 95% CI: 2.27–3.27; hospital: OR: 1.34, 95% CI: 1.15–1.56). The interventions at the child education centers had the most significant intervention effect (*Figure 3*).

In relation to the intervention tools, there was no significant difference among the different subgroups (Z=0.52, P=0.605), suggesting that the use of CRS was increased regardless of whether the interventions were based on mobile technology or general education programs (*Figure 4*).

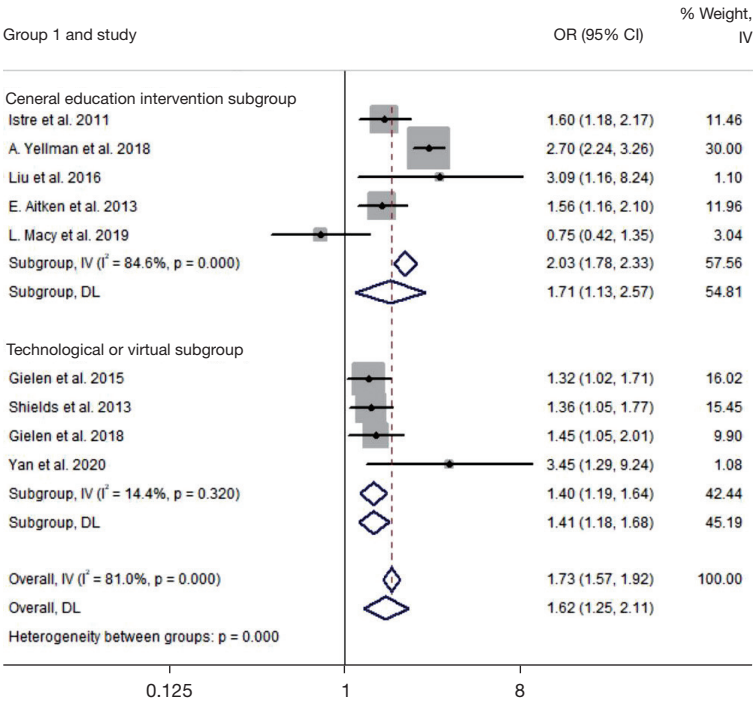

Figure 4 Subgroup analysis of the intervention methods. CI, confidence interval; OR, odds ratio.

The moderator analyses showed that the effects of interventions guided by theories were statistically significant (OR: 1.44, 95% CI: 1.27–1.63). The difference in the use of CRS between the groups in studies without a theory was not statistically significant, revealing that interventions guided by behavioral theories may be a source of heterogeneity (*Figure 5*).

Discussion

In total, 9 studies, comprising 22,329 parents of children aged 0–12 years, were included in this meta-analysis. A strict quality evaluation of these studies was performed. Based on the in-depth and systematic evaluation of the included articles, the meta-analysis results suggested that parent-targeted interventions increase the use of CRS. Interventions with parents have been found to provide an effective parenting strategy (30). Unlike the mandatory nature of law, this strategy focuses on the acquisition of knowledge and skills, which has a positive effect on parents' social psychology (31). This psychological effect may motivate parents to engage in action to increase their knowledge of traffic safety or use effective restraints to prevent possible injury to their children (32).

The meta-analysis also indicated that interventions guided by behavioral theories significantly increased the use of CRS. According to Istre *et al.* (28), the use of a safe community model allowed community subjects to engage in the design and decision-making of child injury prevention measures, and enhanced parents' intuitive feeling of the necessity of using CRS. In the included studies, rather than using a single theory, some researchers integrated multiple theories into the design interventions. For example, Aitken *et al.* (27), combined the Consumer Information Processing model with the Strike Out model to make parents aware of the importance of using correct restraint devices, and contacted considerable rural parents conveniently and efficiently, which effectively promoted parents to adopt preventive measures to reduce child injuries. Gielen *et al.* (24) combined the Precaution Adoption Process Model with the Elaboration Likelihood Model to evaluate the motivation and ability of the parents to use CRS based on different stages of parents' cognition of the use of CRS and convey the information in a more positive way to the participants.

Sabouri *et al.* (33) revealed that public health and health promotion interventions based on social and behavioral science theories were more effective than interventions

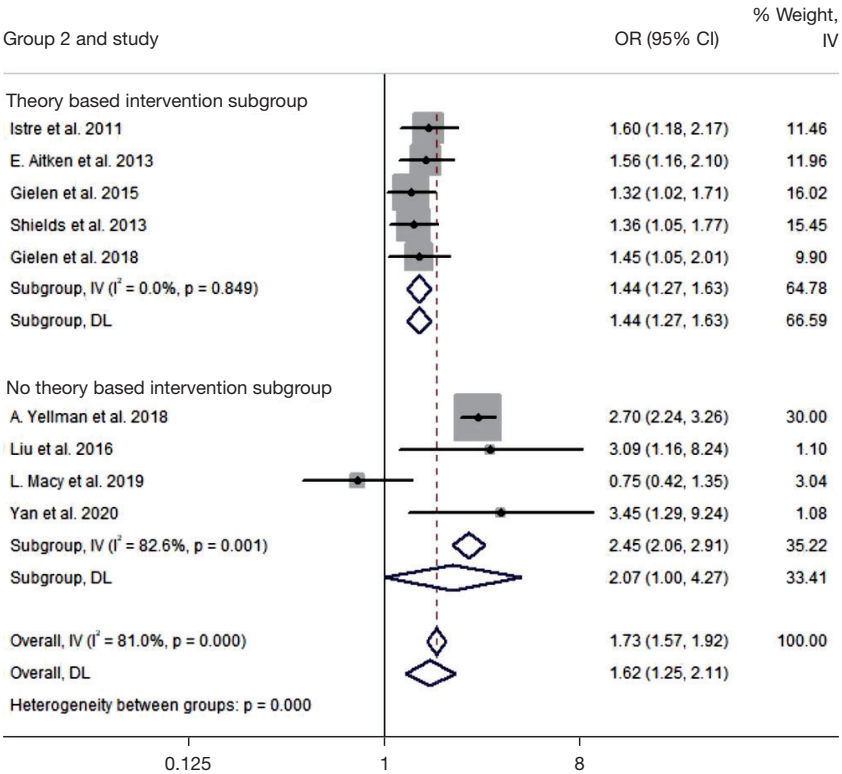

Figure 5 Intervention measures based on the theoretical subgroup analysis. CI, confidence interval; OR, odds ratio.

without a theoretical basis. Intervention measures based on theories may provide parents with more scientific and systematic educational information, change parents' cognition, and provide parents with comprehensive and deep insights into the benefits of using CRS (34). Thus, when travelling by car, parents are more likely to engage in actions to protect children from the possible adverse consequences that may arise if CRS are not use. However, the results of this study may have high heterogeneity due to the difference of theoretical content. Further studies should examine the effect of different theories on promoting the use of CRS.

According to the subgroup analysis of the intervention sites, interventions in communities and at child education centers, and hospitals effectively increased the use of child safety seats, and among these 3 types of interventions, those at child education centers were the most effective. This finding is consistent with that of Orton *et al.* (35). Similarly, Owens (36) found that an intervention for parents at child education centers helped to support parents to implement effective preventive measures for their children. Child education center environments create an opportunity to provide preventive interventions to a considerable number of parents, increase the sensitivity of intervention issues, and play a unique role in behavior change.

The results of the subgroup analysis of the intervention methods suggest that interventions based on mobile technology effectively increased the use of CRS. However, the effect from general education interventions was better, which may be related to the fact that mobile technology was not widely accepted among the study population. In recent years, mobile health interventions have been used as an emerging method to improve national health and increase the level of medical and health care services, and the public's awareness of it has increased (37). However, compared to general education interventions, the public's acceptance of mobile health interventions remains low. Most parents prefer conventional intervention modes, and it will take time for parents to accept emerging technologies (18). Previous studies have shown that interventions based on mobile technology are progressively becoming more popular, and play an increasingly important role in public health and health promotion (38,39). In the future, interdisciplinary collaborations could be considered to

design the optimal interventions to maximize the advantages of mobile technology.

This meta-analysis had several strengths. First, the searches were conducted across multiple databases, and the reference lists and related articles being manually reviewed, which reduced the likelihood of missing related studies. Second, inclusion decisions and data extractions were performed independently and in duplicate, reducing potential for errors and bias. Third, the meta-analysis included large-scale studies on CRS use, had a large sample size, and analyzed the characteristics and result differences of various intervention measures in detail. Finally, multiple subgroup analyses with potential influencing factors were conducted, and the relationship between theoretical guidance and CRS use was demonstrated. Thus, the meta-analysis results provide an objective basis for the development of targeted intervention measures to increase the use of CRS.

Limitations

This study had a number of limitations. First, the number of included articles was small. Second, few studies were included in each outcome index. Third, the heterogeneity of the included articles was high. Finally, the intervention measures and the theories used of the included articles differed, which had a certain effect on the results.

Conclusions

Parent-oriented interventions increase the use of CRS, and theory-based interventions significantly affect outcome indicators. However, there was high heterogeneity in the studies included in the meta-analysis. In the future, high-quality RCTs with large samples should be conducted at multi-centers and allocation concealment and blind evaluation should be strictly implemented to further verify the conclusions of this study.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-22-560/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-22-560/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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