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REVIEW

Playful and game-based oral health education for children in Latin America

Educación en salud bucal lúdica y basada en juegos para niños de América Latina

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ABSTRACT

Introduction: Dental caries remains frequent among children in Latin America, and schools and clinics often teach oral hygiene through games, puppets and other playful formats. No regional synthesis was identified. Methods: Systematic review following PRISMA 2020 of reports published from 2013 to 2025 in English, Spanish or Portuguese, searched in five databases. Eligible studies evaluated playful or game-based oral health education in children and adolescents living in Latin America and reported knowledge, plaque, hygiene or gingival outcomes. Results: A total of 24 studies from seven countries were included, 12 of them from Brazil. Two were randomized, 4 were controlled and non-randomized, and 18 were uncontrolled before-after studies. Knowledge improved in 13 of the 15 studies that measured it, and plaque or hygiene indices improved in 14 of 15. Gingival outcomes were reported by 2 studies. In the 6 controlled comparisons, the playful arm was equal or better than the comparator on every reported outcome. Risk of bias was critical in 16 studies, serious in 2, of some concern in 1, and not assessable in 5. Conclusions: Playful education is associated with better knowledge and plaque control in Latin American children, but the evidence is mostly uncontrolled, short term and of very low certainty, and it does not allow estimates of effect size or conclusions on gingival health.

Keywords: health education dental; play and playthings; child; oral hygiene; Latin America.

RESUMEN

Introducción: La caries dental sigue siendo frecuente en la niñez de América Latina, y escuelas y consultorios enseñan la higiene bucal con juegos, títeres y otros formatos lúdicos. No se identificó una síntesis regional. Métodos: Revisión sistemática según PRISMA 2020 de informes publicados de 2013 a 2025 en inglés, español o portugués, buscados en cinco bases. Se eligieron estudios de educación en salud bucal lúdica o con juegos en niños y adolescentes de América Latina que reportaron conocimiento, placa, higiene o desenlaces gingivales. El riesgo de sesgo siguió ROBINS-I y RoB 2, y la síntesis fue narrativa. Resultados: Se incluyeron 24 estudios de siete países, 12 de ellos de Brasil. Dos fueron aleatorizados, 4 controlados no aleatorizados y 18 antes-después sin control. El conocimiento mejoró en 13 de los 15 estudios que lo midieron, y los índices de placa o higiene mejoraron en 14 de 15. Dos estudios reportaron desenlaces gingivales. En las 6 comparaciones controladas, el brazo lúdico fue igual o mejor que el comparador en todos los desenlaces reportados. El riesgo de sesgo fue crítico en 16 estudios, serio en 2, con algunas dudas en 1 y no evaluable en 5. Conclusiones: La educación lúdica se asocia con mayor conocimiento y mejor control de placa en niños latinoamericanos, pero la evidencia es en su mayoría no controlada, de corto plazo y de certeza muy baja, y no permite estimar la magnitud del efecto ni concluir sobre salud gingival.

Palabras clave: educación en salud dental; juego e implementos de juego; niño; higiene bucal; América Latina.

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INTRODUCTION

Dental caries remains a frequent condition among children in Latin America. A regional systematic review that pooled studies published in the new century estimated that more than half of the children in Latin America and the Caribbean were affected, with prevalence higher outside Brazil than in Brazil.(1)A regional consensus later described persistent inequalities, a high burden of untreated decay and outdated or absent estimates in several countries.(2,3) Community strategies against caries in the region have centred on fluoride and sealants, while documented interventions that restrict sugar consumption, including educational ones, were scarce.(4)

Teaching oral hygiene is the entry point of most school and clinic programs, and many use games, puppets, stories or comics to hold the attention of children. A review of school-based programs found that traditional education reduced plaque but not gingivitis, and that long-term evidence was missing.(5)Systematic reviews of game-based teaching reported better knowledge and plaque scores than conventional lessons.(6,7) A review of playful interventions aimed at health literacy in children aged 6 to 12 years, in turn, found mostly low methodological quality and no evidence of retention over time.(8)Studies from Latin America appear largely in Spanish and Portuguese, in regional journals and university repositories. No systematic review of this type centred on the region was identified in the searches for this work, and it remains unclear what the region has tested and what its results show.

The objective of this review was to determine whether playful and game-based oral health education improves oral hygiene knowledge, plaque or gingival indices in Latin American children compared with conventional education or no intervention. Four questions organize the work. P1: which playful strategies, populations and settings have been evaluated in Latin America? P2: what changes in oral health knowledge have been reported? P3: what changes in plaque, oral hygiene and gingival indices have been reported? P4: how reliable is the evidence, given the designs and the risk of bias of the studies?

METHODS

Design

The review followed the PRISMA 2020 statement and its explanation and elaboration document,(9,10) with PRISMA-S for the reporting of searches(11)and the SWiM guideline for synthesis without meta-analysis.(12)

Eligibility criteria (PICO)

Population: children and adolescents up to 18 years living in a Latin American country, defined as the countries of Mexico, Central America, South America and the Spanish- and Portuguese-speaking Caribbean, including children with special health care needs. Studies of parents, teachers or adults, and studies whose participants included adults that could not be separated, were excluded.

Intervention: oral health education in which a playful or game-based element was a documented component, namely games, serious games or digital games, virtual reality with game elements, puppet or drama performances, storytelling, comics or other ludic activities. Programs that combined these elements with lectures or supervised toothbrushing were eligible when the playful element was described.

Comparator: conventional or expository education, no intervention, or the baseline condition in uncontrolled before-after designs. Studies without a baseline or a comparator were excluded.

Outcomes: oral hygiene knowledge (P2); dental plaque, simplified oral hygiene indices and gingival indices (P3). Self-reported or observed oral hygiene behaviour was accepted as a secondary outcome. Caries incidence and quality of life were not outcomes of this review, although studies that reported them were not excluded for that reason.

Setting: schools, nursery schools, clinics and community services were all accepted, and no minimum follow-up or sample size was required.

Design and timing: randomized, non-randomized controlled and uncontrolled before-after studies, published from 2013 to 2025 in English, Spanish or Portuguese. Protocols, development and validation studies without outcomes, experience reports and qualitative studies without measured outcomes were excluded.

Operational definitions

The setting was defined by the place where the children received the intervention, not by the affiliation of the authors; a study carried out in a Venezuelan school by Cuban authors was therefore eligible. A playful element was considered documented when the report described a game, a puppet or drama performance, a story, a comic or another activity explicitly presented as ludic or recreational. Reports that mentioned only didactic, participatory or interactive techniques were not classified as playful.

Interventions that combined playful elements with lectures, demonstrations or supervised toothbrushing were kept as multicomponent programs, and their results were attributed to the whole program, because the effect of the playful element alone could not be separated in any of them. Plaque and hygiene outcomes comprised the simplified oral hygiene index, the Love and O'Leary indices, visible plaque scores and the plaque component of the Greene and Vermillion index. Knowledge was defined as the score, level or percentage of correct answers on a questionnaire or interview on oral hygiene, diet or caries.

Information sources and search strategy

Scopus, PubMed, OpenAlex, Crossref and Semantic Scholar were searched for reports published from 2013 to 2025. A total of 78 searches for core studies were run in these sources, in English, Spanish and Portuguese, combining terms for oral health education, playful formats and children with country names, and, in Scopus, affiliation country filters. The regional indexes SciELO, Redalyc and LILACS were not searched directly; their journals were reached through OpenAlex and Crossref. The first Scopus string was: TITLE-ABS-KEY((“oral health education” OR “oral hygiene” OR “dental plaque” OR “dental caries”) AND (game OR games OR gamification OR playful OR ludic OR “serious game” OR “board game” OR “educational game”) AND (child* OR school*) AND (Brazil OR Brasil OR Mexico OR Colombia OR Chile OR Argentina OR Peru OR “Latin America” OR Ecuador OR Venezuela OR Uruguay OR Paraguay OR Bolivia OR Cuba OR “Costa Rica”)) AND PUBYEAR > 2012 AND PUBYEAR < 2026. The first PubMed string was: ((“oral health education” OR “oral hygiene” OR “dental plaque” OR “dental caries” OR “health education, dental”) AND (game OR games OR gamification OR playful OR ludic OR “serious game” OR “educational game” OR puppet OR storytelling OR “board game”) AND (child OR children OR schoolchildren OR preschool) AND (Brazil OR Brasil OR Mexico OR Colombia OR Chile OR Argentina OR Peru OR “Latin America” OR Ecuador OR Venezuela OR Uruguay OR Cuba OR “Costa Rica”)). The remaining strings used Spanish and Portuguese terms such as lúdico, jogo educativo, juego didáctico, títeres, fantoches and educação em saúde bucal, and they are available from the authors. Reference lists were not screened and experts were not contacted.

Decisions taken during full-text assessment

Several decisions were not anticipated in the eligibility criteria and are reported here to allow other readers to judge them. A program in Puno, Peru, was described in a journal article and in a university project report; the two reports were treated as one study and then excluded because the dramatizations were directed to parents and only 14 children were examined. A study of children with Down syndrome aged 6 to 32 years was excluded because the results of children could not be separated from those of adults.

Reports in which the intervention was described only as didactic, participatory or motivational were excluded as having no documented playful component, even when the title suggested otherwise. Studies that evaluated only the acceptance of a game by children, such as the satisfaction with a software or the opinion about a serious game, were excluded for the absence of knowledge, plaque or gingival outcomes. One Venezuelan study of a game for brushing technique in 13 children was excluded because its journal issue was dated 2012.

Risk of bias

Randomized trials were appraised with RoB 2(18)and non-randomized studies with ROBINS-I,(19)applied at the level of the overall judgement because most reports lacked the detail needed for every domain. Uncontrolled before-after studies were rated as critical for confounding, since changes over time and concurrent school activities cannot be separated from the intervention. Studies for which only the abstract was available were rated as not assessable. The certainty of the evidence was judged narratively and was not graded with GRADE.

Synthesis

Studies were grouped by outcome and by design. Pooling was not attempted because the studies used different instruments, indices and time points, reported few measures of dispersion and rarely compared arms. The direction of each reported result was tabulated and summarized as counts of studies, following SWiM, and no effect sizes were derived.

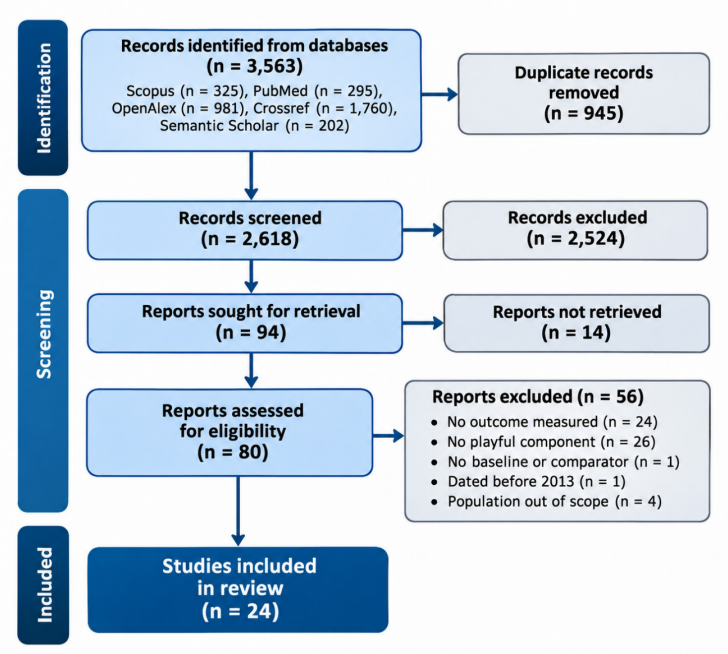
A result was classed as improved when the post-intervention value or the playful arm was better than the baseline or the comparator and the authors reported the difference as significant or, when no test was reported, when the change was in the favourable direction. It was classed as no change when the authors reported a non-significant difference. Subgroup findings were reported separately and did not change the classification of the study as a whole, except where stated.

RESULTS

Twenty-four studies from seven countries, mostly uncontrolled before-after designs

The searches identified 3,563 records, of which 945 duplicates were removed and 2,618 were screened (Figure 1). Screening excluded 2,524 records, and 94 reports were sought for retrieval; 14 could not be retrieved because the full text and an informative abstract were both unavailable. The remaining 80 reports were assessed, 56 were excluded and 24 studies were included.

Figure 1. PRISMA 2020 flow diagram of the selection of studies.



The reasons for exclusion at full-text assessment corresponded to the absence of a documented playful component in 26 reports, the absence of a measured outcome in 24 reports, a population outside the scope in 4 reports, the absence of a baseline or comparator in 1 report and an issue dated before 2013 in 1 report. The 4 reports in the population group comprised two reports of one parent-directed program in Peru, whose dramatizations were delivered to caregivers, one study of teachers and one study with participants aged 6 to 32 years that could not be separated.

The included studies (Table 1) were published from 2013 to 2025, 12 of them in 2013 to 2018 and 12 in 2019 to 2025. Brazil contributed 12 studies, Peru 4, Colombia 3, Cuba 2, and Mexico, Venezuela and Nicaragua 1 each. Nineteen reports were published in Spanish or Portuguese, some with English versions. Sample sizes ranged from 14 to 479 participants, with a median of 50 among the 23 studies that reported a size, and 7 studies enrolled preschool children. Four studies were conducted with children with hearing impairment or intellectual disability.

The children were 3 to 5 years old in 4 studies, 4 to 6 years old in 1 study, and 5 to 6 years old in 1 study, whereas the others enrolled school-age children from 5 to 12 years, and 2 studies exten-

ded to adolescents up to 17 or 18 years. The samples were drawn from public nursery schools and schools, from special schools in 4 studies, from a football school in Colombia,(28)from a rural school in Brazil(23)and from a pediatric dental clinic in the Brazilian Amazon.(36)Boys formed 92% of the Colombian football school sample.

Table 1. Characteristics of the included studies.

Study	Country	Design	Participants	Playful strategy	Comparator
Stürmer Badalotti et al.(20)	Brazil	BA	41 children, 4 to 6 years	Story-based meetings with a children series	Baseline
García Rupaya and González Chávez (a)(13)	Peru	NRCT	224 children, 3 to 5 years	Participatory and ludic program Sonrisa feliz	Expository program
Torres Gárriz et al.(21)	Cuba	BA	40 children, 7 to 11 years, intellectual disability	Games and puppets	Baseline
Gutiérrez Ilave et al. (a)(14)	Peru	NRCT	Children, 8 to 9 years, n NR	Rule game DENTOPLAY	Expository teaching
Evaristo-Chiyong et al. (a)(15)	Peru	BA	28 children, 7 to 9 years	Ludic strategy	Baseline
Da Cruz et al.(22)	Brazil	BA	64 children, 9 to 12 years	Lecture followed by educational games	Baseline
Oliveira et al.(23)	Brazil	BA	72 children, 5 to 12 years, rural	Hero characters, theatre and games	Baseline
Barreto et al.(24)	Brazil	RCT	38 children, 3 to 5 years	Puppet theatre and interactive play	No activity
Sigaud et al.(25)	Brazil	BA	44 children, 3 to 5 years	Three playful sessions on toothbrushing	Baseline
De Araujo et al. (a)(16)	Brazil	RCT	14 children, 7 to 8 years	Ludic activities plus hygiene instruction	Hygiene instruction
Caetano Araújo et al.(26)	Brazil	NRCT	183 children, 5 to 6 years	Recreational activities, lectures and supervised brushing	No program
Aguiar et al. (a)(17)	Brazil	BA	29 students, 11 to 17 years	Card game Jogo SB	Baseline
Ávila-Curiel et al.(27)	Mexico	BA	25 children, 6 to 11 years, hearing impairment	Lottery game, letter soup and colouring	Baseline
Alzamora De La Rosa et al.(28)	Colombia	NRCT	50 children, 6 to 10 years	Comic book	Lecture and demonstration
Rincón Cadavid et al.(29)	Colombia	BA	31 analysed of 41 children, 6 to 18 years, hearing impairment	Puppets, word games and ludic roulette	Baseline
Leal Rodríguez et al.(30)	Venezuela	BA	60 children, 8 to 11 years	Didactic games and participatory techniques	Baseline
Díaz Garavito et al.(31)	Colombia	BA	479 children examined in two surveys, mean age 3 years	Ludic activities with fluoride varnish	Earlier survey
Martins et al.(32)	Brazil	BA	173 children, 6 to 11 years	Theatre and stories with lectures	Baseline
Ramón Leiva et al.(33)	Cuba	BA	26 children, intellectual disability	Games, songs and a story	Baseline
Genaro et al.(34)	Brazil	BA	300 children, 9 to 12 years	Immersive virtual reality and an educational book with games	Baseline
Ladera-Castañeda et al.(35)	Peru	BA	132 children, 3 to 5 years	Puppet theatre, 10 sessions	Baseline
Haad Ruiz da Silva et al.(36)	Brazil	BA	50 children, 6 to 12 years	Playful comic book with a hygiene kit	Baseline
Castro Sánchez and Vanegas Sáenz (37)	Nicaragua	BA	174 children, mean age 9.7 years	Word searches, crosswords and riddles among other techniques	Baseline
Fontes dos Reis et al.(38)	Brazil	BA	177 children, 4th and 5th grade	Digital board game	Baseline

Note: n = number of participants; RCT = randomized controlled trial; NRCT = non-randomized controlled trial; BA = uncontrolled before-after; NR = not reported in the abstract; (a) data from the abstract only.

With respect to design, 2 studies were randomized, 4 were non-randomized and controlled, and 18 were uncontrolled before-after studies. Regarding the playful format, 9 studies were based on games of different types, 6 on puppets, theatre, stories or character-led activities, 6 on general ludic or recreational activities, 2 on comics and 1 on virtual reality. In most studies, the playful element was one component of a program that also included lectures, demonstrations or supervised toothbrushing, and only 6 studies had a comparison arm, which was conventional teaching in 4 and no activity or program in 2.

The programs differed widely in length and intensity. The Peruvian puppet theatre study delivered 10 sessions of 30 minutes over 4 months, with a short question and answer period at the end of each performance.(35)The Mexican program for children with hearing impairment consisted of 3 sessions of about 120 minutes, in which a lottery game with 45 dental pictures was combined with a presentation in Mexican Sign Language.(27) The Brazilian randomized pilot trial used a single activity of 60 minutes with puppets and interactive play.(24)

A Peruvian comparison of two teaching methods in children aged 8 to 9 years used 8 weekly sessions of 45 minutes with the same content in both arms.(14)In Colombia, a program with 48 activities was delivered over about 10 months in groups of about 23 children, weekly and lasting 3 hours.(31)The Cuban programs for children with intellectual disability combined games, songs, a story and puppets over several sessions.(21,33)

Where the delivery agents were reported, they were university-based. First-year dental students delivered the activities in Nicaragua,(37)a university extension team in the Brazilian rural project,(23)and a dental school program team in the Brazilian nursery school comparison.(26)The Brazilian nursery school study of playful sessions was led by a school of nursing.(25)Teachers and parents attended the sessions in the Peruvian puppet study.(35)

Two studies used digital technology. A digital board game was applied in 5 public schools in Rio de Janeiro state,(38)and an immersive virtual reality journey of 8 minutes through a model of the mouth was followed by an educational book with games.(34)Among the non-digital games, a card game with 69 cards was played in groups of 2 to 4 adolescents in the Amazon region.(17)

The review identified 24 studies from 7 countries.

Knowledge improved in 13 of 15 studies, with 2 null results

Knowledge was measured in 15 studies (Table 2). It was quantified with questionnaires or interviews, expressed as mean scores, levels of knowledge or percentages of correct answers. An improvement was reported in 13 studies, whereas 2 reported no change.

Table 2. Reported changes in oral health knowledge.

Study	Measure	Reported result	Direction
García Rupaya and González Chávez (a)(13)	Child questionnaire, 8 items	Mean 6.22 in the playful program and 4.50 in the expository program ($p < 0.05$)	Favoured playful
Torres Gárriz et al.(21)	Interview, 5 questions	Knowledge increased after 6 months, described without a test	Improved
Gutiérrez Ilave et al. (a)(14)	Cognitive component of attitude	Both methods increased knowledge, and the affective component was more positive with the ludic method	Improved in both arms
Evaristo-Chiyong et al. (a)(15)	Questions on caries and hygiene	Recognition of caries as a disease rose from 0% to 37%, and of the hygiene elements from 46.4% to 88%	Improved
Da Cruz et al.(22)	Questionnaire before and after	Significant increase in correct answers in 64 children	Improved
Caetano Araújo et al.(26)	Child knowledge score	Mean 11.62 in the program group and 8.42 in the control group ($p < 0.001$)	Favoured playful
Aguiar et al. (a)(17)	Questionnaire before and after	Correct answers increased by 16.08% on average after the game	Improved
Alzamora De La Rosa et al.(28)	Post-test grade	Excellent grade in 76% with the comic and 28% with the conventional method	Favoured playful
Leal Rodríguez et al.(30)	Global knowledge level	Good level in 13.33% before and 86.67% after	Improved
Díaz Garavito et al.(31)	Parent-reported hygiene knowledge	No significant difference between 2015 and 2017	No change
Ramón Leiva et al.(33)	Information level	Poor in 69.23% before; good in 38.46% and regular in 46.15% after	Improved

Study	Measure	Reported result	Direction
Genaro et al.(34)	Oral hygiene knowledge	No difference before and after (p = 0.550)	No change
Ladera-Castañeda et al.(35)	Five-question test	Improvement at 4 weeks and 4 months (p < 0.001), except in rural children	Improved
Castro Sánchez and Vanegas Sáenz (37)	General and oral health score	Mean 9.66 before and 10.76 after (p < 0.001)	Improved
Fontes dos Reis et al.(38)	Eight questions before and after	Errors decreased in every question (p < 0.01)	Improved

Note: (a) data from the abstract only. IHOS = simplified oral hygiene index. p values are those reported by the authors; blank cells indicate that no test was reported.

Among the controlled studies, the playful arm showed higher knowledge than the comparator in 3 of them, with a mean of 6.22 against 4.50 in preschool children from Peru, 11.62 against 8.42 in Brazil and an excellent grade in 76% against 28% in Colombia. The fourth controlled study, which compared a rule game with an expository method in Peru, reported gains in both arms. Among the uncontrolled studies, 9 reported gains and 2 reported no change. The 2 null results corresponded to a virtual reality program in Brazil and a program with fluoride varnish in a Colombian preschool.

The Peruvian puppet theatre study showed gains in knowledge in urban children at 4 weeks and 4 months but not in rural children (p > 0.05). Regarding the time course, the Peruvian puppet theatre study measured knowledge at 4 weeks and at 4 months and found gains at both points in urban children.(35)The Peruvian comparison in preschool children also measured the knowledge of their parents, which reached a mean of 10.79 in the playful program against 9.05 in the expository one on a 15-item questionnaire.(13)The Cuban program in Baraguá measured knowledge before the intervention and 6 months after it.(21)

Further detail came from the Peruvian study of 28 children, in which the proportion that linked brushing moments to meals rose from 17.9% to 56% and the proportion that identified sealants as a preventive measure rose from 28% to 74%.(15)In Venezuela, the three themes evaluated separately also improved.(30)In the Colombian comic study, the control group trained with lectures and demonstrations obtained an excellent grade in 28% of cases.(28)

Knowledge improved in 13 of the 15 studies that measured it.

Plaque or hygiene indices improved in 14 of 15 studies, and gingival evidence was limited to 2

Plaque or oral hygiene indices were reported with results in 15 studies, gingival outcomes in 2 and behaviours in 4 (Table 3). At least four different indices were used, namely the simplified oral hygiene index, the Love index, the O'Leary index and the visible plaque index. Follow-up ranged from 3 weeks to 6 months, except in one comparison of two surveys 2 years apart.

With respect to the controlled studies, the plaque or hygiene outcome favoured the playful arm in the 3 that reported a between-arm comparison, with visible plaque of 15.24% against 43.63% in a Brazilian randomized trial of 38 preschool children, a simplified oral hygiene index of 1.08 against 1.56 in Peru, and a mean improvement of 0.16 against a worsening of 0.27 in a randomized trial of 14 children. The Colombian comic study reported significant within-group improvement in the comic arm and a non-significant one in the control arm. The Brazilian randomized trial also quantified gingival bleeding at 0% in the playful arm and 7.67% in the control arm.

Among the uncontrolled studies, 10 of 11 reported improved indices. The exception was a Brazilian story-based program in preschool children, in which visible plaque and gingival bleeding showed no significant change, and the Peruvian puppet study showed no change in rural children. Regarding behaviours, all 4 studies that reported them showed improvements in toothbrushing technique, flossing or brushing frequency, although the Brazilian comic book changed flossing but not brushing frequency.

In the Brazilian randomized pilot trial, visible plaque fell from 40.31% to 15.24% in the playful arm (p = 0.001) and rose from 35.04% to 43.63% in the control arm (p < 0.001), with an effect size of 1.10 between arms at the end.(24)In the Peruvian puppet theatre study, the plaque index fell in urban children at 4 weeks and 4 months (p < 0.001) but not in rural children (p = 0.097).(35)

The Brazilian study of theatre and stories compared 3 age groups at 2 and 4 weeks.(32) The mean index of the 6 to 7 year group fell from 1.6 in girls and 1.9 in boys to 0.89 and 1.13 at 2 weeks, and the improvement persisted at 4 weeks in the 6 to 7 and the 10 to 11 year groups. In the 8 to 9 year group, the improvement persisted only in girls, and the values of boys at 4 weeks were close to their baseline.

Table 3. Reported changes in plaque, oral hygiene, gingival and behaviour outcomes.

Study	Outcome	Reported result	Direction
Stürmer Badalotti et al.(20)	Visible plaque and gingival bleeding	VPI 70.1% to 63.4% (p = 0.48); GBI 34.0% to 29.3% (p = 0.35)	No significant change
García Rupaya and González Chávez (a)(13)	SOHI	1.08 in the playful program and 1.56 in the expository program (p < 0.05)	Favoured playful
Torres Gárriz et al.(21)	Love index; brushing after dinner and at bedtime	Adequate hygiene in 15% before and 75% after (p = 0.00); brushing at bedtime 0% to 70%	Improved
Oliveira et al.(23)	SOHI	Mean 1.96 before and 1.43 after 6 months	Improved
Barreto et al.(24)	Visible plaque and gingival bleeding	Plaque 15.24% against 43.63% (p = 0.005); bleeding 0% against 7.67% (p = 0.004)	Favoured playful
Sigaud et al.(25)	Adequate toothbrushing behaviours, 10 observed	Mean 4.4 before and 8.5 after (p < 0.01)	Improved
De Araujo et al. (a)(16)	SOHI	Mean improvement of 0.16 in the playful group and worsening of 0.27 in the control group (significant)	Favoured playful
Ávila-Curiel et al.(27)	SOHI categories	Good in 12% before and 64% after; deficient in 44% before and 0% after	Improved
Alzamora De La Rosa et al.(28)	O'Leary biofilm index	High index in 12% before and 4% after with the comic (p = 0.012); control group p = 0.082	Improved with comic
Rincón Cadavid et al.(29)	Plaque index	Significant decrease between the first and second examination	Improved
Leal Rodríguez et al.(30)	Love index	Deficient in 90% before and good in 93.3% after	Improved
Díaz Garavito et al.(31)	Plaque index	Median 42 in 2015 and 36 in 2017 (p = 0.035)	Improved
Martins et al.(32)	SOHI	Lower at 2 and 4 weeks than before in most age and sex groups (p < 0.05)	Improved
Ramón Leiva et al.(33)	Oral hygiene	Poor in 76.92% before and 23.08% after	Improved
Genaro et al.(34)	Flossing, tongue brushing and toothbrushing frequency	Increases in the three behaviours (p < 0.001)	Improved
Ladera-Castañeda et al.(35)	Bacterial plaque index	1.85, 1.77 and 1.84 before and 0.89, 0.82 and 0.90 after 4 months in the 3, 4 and 5 year groups (p < 0.001)	Improved, not in rural children
Haad Ruiz da Silva et al.(36)	Flossing and toothbrushing frequency reported by parents	Flossing rose in 55.32% of children (p = 0.0401); brushing frequency did not change (p = 0.873)	Improved flossing only
Castro Sánchez and Vanegas Sáenz (37)	O'Leary index	28.28% before and 12.98% after (p < 0.001)	Improved

Note: (a) data from the abstract only. SOHI = simplified oral hygiene index; VPI = visible plaque index; GBI = gingival bleeding index. p values are those reported by the authors; blank cells indicate that no test was reported.

The youngest group showed the largest improvement. Two studies reported caries or a related measure as an additional outcome. The Colombian program with fluoride varnish reported lower numbers of decayed teeth with cavitation and of white spot lesions (p < 0.001) and a decrease in the median caries experience index from 2 to 0.(31)The Brazilian story-based program reported a mean of 1.99 decayed teeth before and 1.54 after (p = 0.08).(20)

Behaviour outcomes were measured in different ways. The Brazilian nursery school study observed 10 toothbrushing behaviours, of which a mean of 4.4 were adequate before and 8.5 after the playful sessions.(25)In the Cuban program for children with intellectual disability, the proportion who brushed after dinner rose from 40% to 75%, and the proportion who brushed with a vertical movement rose from 5% to 90%.(21)The Brazilian comic book increased flossing by 55.32% of the children, and virtual reality increased flossing, tongue brushing and brushing frequency.(34,36)

Plaque or hygiene indices improved in 14 of 15 studies.

Risk of bias was critical, serious or unassessable in 23 of 24 studies

Table 4. Risk of bias of the included studies.

Study	Design	Overall risk	Main concerns
Stürmer Badalotti et al.(20)	BA	Critical	No comparator, 41 children, no significant change reported
García Rupaya and González Chávez (13)	NRCT	NA	Abstract only
Torres Gárriz et al.(21)	BA	Critical	No comparator, 40 children, habits collected by interview
Gutiérrez Ilave et al.(14)	NRCT	NA	Abstract only
Evaristo-Chiyong et al.(15)	BA	NA	Abstract only
Da Cruz et al.(22)	BA	Critical	No comparator, convenience sample, questionnaire only
Oliveira et al.(23)	BA	Critical	No comparator, no statistical test reported for the index change
Barreto et al.(24)	RCT	Some concerns	Allocation method not described, main researcher examined the children, 38 children
Sigaud et al.(25)	BA	Critical	No comparator, 44 children, observed behaviours
De Araujo et al.(16)	RCT	NA	Abstract only, 14 children
Caetano Araújo et al.(26)	NRCT	Serious	Post-intervention comparison only, no baseline knowledge, intervention assigned by nursery school
Aguiar et al.(17)	BA	NA	Abstract only
Ávila-Curiel et al.(27)	BA	Critical	No comparator, 25 children, no statistical test reported
Alzamora De La Rosa et al.(28)	NRCT	Serious	Allocation not randomized, convenience distribution, 50 children from one football school
Rincón Cadavid et al.(29)	BA	Critical	No comparator, 10 of 41 participants not analysed
Leal Rodríguez et al.(30)	BA	Critical	No comparator, pre-experimental design, 60 children
Díaz Garavito et al.(31)	BA	Critical	Two surveys with different numbers of children, co-intervention with fluoride varnish
Martins et al.(32)	BA	Critical	No comparator, inconsistent sample counts, follow-up of 4 weeks
Ramón Leiva et al.(33)	BA	Critical	No comparator, 26 children
Genaro et al.(34)	BA	Critical	No comparator, questionnaire-based behaviours
Ladera-Castañeda et al.(35)	BA	Critical	No comparator, main researcher performed the evaluations
Haad Ruiz da Silva et al.(36)	BA	Critical	No comparator, outcomes reported by parents
Castro Sánchez and Vanegas Sáenz (37)	BA	Critical	No comparator, games were one of several techniques
Fontes dos Reis et al.(38)	BA	Critical	No comparator, same questionnaire before and after

Note: Overall judgement only. RoB 2 was applied to randomized trials and ROBINS-I to the other designs. Critical = changes over time cannot be separated from the intervention; NA = not assessable because only the abstract was available.

Risk of bias was rated as critical in 16 studies, all of them uncontrolled before-after designs (Table 4). Two non-randomized controlled studies were rated as serious, one randomized pilot trial as of some concern, and 5 studies, for which only the abstract was available, as not assessable.

The 2 randomized trials enrolled 38 and 14 children, and the 4 controlled non-randomized studies did not randomize allocation. All 18 uncontrolled studies measured outcomes before and after the activity, and several reported percentages without a statistical test. The Peruvian puppet theatre study calculated its sample size from a pilot of 30 preschool children, and no other study reported a sample size calculation.

The longest follow-up of the same children was 6 months, and one Colombian study lost 10 of 41 participants. A formal GRADE assessment was not made, and the certainty of the evidence was judged very low for knowledge, plaque and gingival outcomes.Risk of bias was critical, serious or not assessable in 23 of the 24 studies.

DISCUSSION

Does playful education improve oral hygiene knowledge, plaque or gingival indices in Latin American children? The studies point in the same direction. They do not, however, allow a quantified answer. Playful and game-based formats were associated with better knowledge and lower plaque in most reports, and in all 6 controlled comparisons they were equal or better than conventional teaching, yet 18 of the 24 studies had no comparator and none followed the same children beyond 6 months.

The first question concerns what the region has tested (P1), and the answer is a small and uneven set of studies. Brazil and Peru supplied 16 of the 24 studies, while Argentina, Chile, Ecuador, Uruguay and Central America other than Nicaragua contributed none. The formats used, namely games, puppets, storytelling and comics, are the same as those described in reviews of other regions.(7,8) The programs were short. Several were delivered in schools by university students or health professionals. The scarcity of educational interventions against caries documented for the region fits this picture,(4)and it is plausible that the work is driven by university outreach projects rather than by funded trials, which would explain the small samples and the weak designs. Four of the 24 studies involved children with hearing impairment or intellectual disability, which shows that playful formats are being adapted to children who are difficult to reach with lectures.

The second question concerns the changes in knowledge (P2), and knowledge was usually higher after playful teaching. The 13 improvements agree with a systematic review of 7 randomized trials, which found better knowledge after game-based teaching than after traditional teaching,(6) and with trials from India in which a crossword and quiz format, a board game and a dice game combined with lectures gave higher knowledge between 1 and 6 months.(39-41)In a board game trial with preschool children, gains persisted at 3 months in both age groups taught with the game, whereas the youngest children taught with slides returned to their baseline.(42)Conversely, a computer game was as effective as one-to-one education for children at high caries risk, and not better,(43)and a meta-analysis of e-learning found no advantage over conventional education.(44) The Latin American controlled studies, in which the playful arm exceeded the conventional one, resemble the first group of results, but the differences were measured with different instruments and in small samples, so their size cannot be compared across studies. The 2 null results suggest where effects may fail. In the Colombian program, the knowledge reported by parents was assessed in two separate surveys and fluoride varnish was applied at the same time. In the virtual reality program in Brazil, knowledge of oral hygiene did not change while self-reported behaviours did. A possible reading is that immersive formats move behaviour more than knowledge, but a single study cannot confirm it.

As for the third question, plaque, hygiene and gingival indices (P3), 14 of 15 studies reported improvement, and the controlled ones reported lower plaque with the playful arm. This matches the reductions in plaque scores found in trials of game-based education outside the region,(6,45) including adults with intellectual disability, and a pooled analysis in which theory-based programs reduced plaque.(46)It also matches the observation that traditional school education reduces plaque,(5)so the studies do not show that the playful element adds to the effect of supervised toothbrushing or lectures that accompanied many programs. Gingival evidence is the weak point. Only 2 studies measured it; one showed no significant change and the other, a pilot trial of 38 children, showed no bleeding in the playful arm and an increase in the control arm. The school-based review found no effect of traditional education on gingivitis,(5)whereas a review of programs in low and middle income countries reported improved gingival health,(47)so the question remains open for playful formats in the region.

Plaque is a short-term marker, and improvements seen from 3 weeks to 6 months can reflect the motivation generated by the activity and by supervised brushing. The Peruvian puppet study showed no significant plaque reduction in rural children, and the Brazilian story-based program in preschool children did not reduce plaque or bleeding significantly. These results indicate that the effect is not universal and may depend on dose, age and the support of the school routine, although the studies do not allow these factors to be separated.

The fourth question, the reliability of the evidence (P4), has a direct answer: it is low. Sixteen studies were rated critical for confounding because they compared children with themselves before and after an activity, and 5 were not assessable because the full text could not be obtained. Reviews of gamification in children's oral health and of playful health literacy reported moderate risk of bias in 39 of 41 studies and low methodological quality, respectively,(7,8) so the Latin American literature is not an outlier, although its share of uncontrolled designs is high. Mobile applications and augmented reality are prominent formats in the gamification literature,(7)and few applications

focus on oral hygiene education.(48)In this review only 2 studies used a digital game or virtual reality and none used an application with a comparator, so the regional evidence does not yet support claims about digital tools.

A plausible mechanism for the pattern observed is engagement. The gamification review reported higher participation and better adherence to hygiene routines in gamified interventions,(7) and the review of playful health literacy interventions found that games, drama and theatre were the formats most often used to increase health knowledge.(8)In the Latin American studies, the reports describe attentive and participative children, but only a few measured engagement, so the mechanism remains an interpretation and not a finding.

Pooled estimates outside the region give a scale of reference. Theory-based programs for children and adolescents raised knowledge with a standardized mean difference of 1.09,(46) and the pooled analysis of school-based education in low and middle income countries also found gains in knowledge, behaviour and oral hygiene.(47)The regional studies cannot be placed on that scale, because most did not report dispersion and the instruments were not common. Reading a pooled estimate into them would give a false precision.

For policy in the region, the consensus on caries emphasizes inequalities and the need for population-wide strategies that are affordable.(2,4) Several programs were applied by university teams in public schools, so playful teaching could complement that approach. The present evidence supports using it to engage children in the school setting, and does not support presenting it as a stand-alone caries prevention strategy.

Four studies in children with hearing impairment or intellectual disability reported better hygiene indices after programs that adapted their content, using Mexican Sign Language, puppets, songs or simple games.(21,27,29,33)All four were uncontrolled and small, with between 25 and 41 children, so they offer a signal and not evidence, but they show that the format can be adapted to communication needs that conventional lectures do not meet well.

Age and context may modify the effect. The Brazilian study of theatre and stories found the largest improvement in the youngest children,(32)the Peruvian puppet study found no significant change in rural children,(35)and a board game trial outside the region found that retention differed by age and by teaching method.(42) These observations suggest that a program should be adjusted to the age of the children and to the school routine, and that trials should report effects separately by age group, by sex and by urban or rural setting.

This review adds two points to the international literature. First, it shows that playful formats have been tested in at least seven Latin American countries, in public schools and special schools, with results that point in the same direction as the trials from other regions. Second, it shows where the regional evidence differs from that literature: the proportion of uncontrolled designs is high, the instruments are not harmonized, and the follow-up is short. Both points are relevant for anyone planning a program or a trial in the region, because they indicate which designs would add information and which would repeat what is already known.

For practice, playful formats seem a low-risk way to teach toothbrushing and diet to children, and the available data do not show harm, but they do not justify replacing supervised toothbrushing and fluoride-based strategies. For research, the next studies should use randomized or controlled designs with masked examiners, a common plaque index, gingival outcomes and follow-up of at least 12 months, and they should report playful components in enough detail to be replicated. Studies in countries not represented here, and in digital formats, are the main gap.

The strengths of the review are its regional scope, the search in three languages with country filters, and the explicit description of what was and was not obtained. Nineteen of the 24 included reports were published in Spanish or Portuguese, and many appeared in journals and repositories that international reviews of game-based teaching do not search, which suggests that the regional literature has been underrepresented in earlier syntheses.(6,7) The use of a common set of outcomes allowed each study to be placed on the same questions, even when the instruments differed.

The instruments are a further obstacle to synthesis. The studies used at least four plaque or hygiene indices, knowledge tests with different numbers of items, and several reported categories rather than means, which prevents the calculation of standardized effects. A consensus set of outcomes for school-based oral health education, as proposed in reviews of theory-based programs,(46)would make the regional studies comparable and would allow a future meta-analysis.

Finally, the comparators deserve attention. Where a conventional arm existed, it consisted of lectures, demonstrations or expository teaching, which are themselves a weak standard because their effect on plaque is small and short.(5)A trial in which the playful arm was compared with an equally intensive conventional arm, delivered by the same person for the same time, would show whether the format or the extra attention explains the difference. Only 2 of the 6 controlled studies

stated that the content and the number of sessions were the same in both arms,(13,14) and the others do not report whether contact time was matched.

CONCLUSIONS

The studies that evaluated playful education in Latin American children came from a few countries and were mostly uncontrolled before-after designs with small samples and short follow-up.

Oral health knowledge was higher after playful and game-based teaching in most of the studies that measured it, and the controlled studies favoured the playful arm.

Plaque and hygiene indices improved in nearly all studies, whereas gingival outcomes were measured too rarely to allow a conclusion.

The evidence is of very low certainty because of confounding, small samples and missing full texts, so the magnitude and the duration of the effect remain unknown.

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