IMPACT OF EXERGAMES ON BMI AND CARDIOVASCULAR RISK FACTORS: A SYSTEMATIC REVIEW

IMPACTO DE EXERGAMES NO IMC E FATORES DE RISCO CARDIOVASCULAR: UMA REVISÃO SISTEMÁTICA

IMPACTO DE EXERGAMES SOBRE IMC Y LOS FACTORES DE RIESGO CARDIOVASCULAR: REVISIÓN SISTEMÁTICA

Systematic Review
Revisão Sistemática
Revisión Sistemática

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ABSTRACT

Introduction: Exergames or active video games are digital platforms with functionality associated with body movement, which dialogue with improving physical activity levels, stimulating pleasure in practice and adherence to change habits, physically active behavior, and better quality of life. Objective: This study aimed to synthesize the available evidence on the contribution of exergame to Body Mass Index, physical activity level, glycemic control, blood pressure, and cardiorespiratory fitness in adolescents. Methods: This is a systematic review, reported following the PRISMA writing recommendations, without language restrictions, for articles indexed in the following databases: MEDLINE / PubMed, Embase, Cochrane Library, and Lilacs. Data extraction was performed analogously in a spreadsheet previously tested and standardized. The assessment of the risk of bias in the included studies was carried out by the RoB 1.0 tool in all of its domains in duplicate of reviewers. Initially, 3.039 studies were found. Results: The studies cover a total of 526 adolescents aged ten to 19. The most used platform in the studies was the Nintendo Wii, followed by the PlayStation, Xbox 360, and Dance Dance Revolution. The results indicated that interventions using exergames were effective for changing BMI, but there was no evidence on cardiovascular outcomes, with no effective changes in glycemic control and blood pressure and a significant response ($p < 0.05$) in cardiorespiratory fitness. Conclusion: The exergame points to satisfactory results in improving health and can be incorporated as a relevant public policy in the adolescent health promotion. (PROSPERO Registration CRD42020181772). ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Physical Exercise; Exergames; Adolescent; Public Health.

RESUMO

Introdução: Exergames ou vídeo games ativos são plataformas digitais com funcionalidade associada ao movimento corporal, que dialogam com a melhora dos níveis de atividade física, estimulando o prazer na prática e a adesão à mudança de hábitos, comportamento ativo e melhor qualidade de vida. Objetivo: Este estudo teve como objetivo sintetizar as evidências disponíveis sobre a contribuição do exergame para o Índice de Massa Corporal, nível de atividade física, controle glicêmico, pressão arterial e aptidão cardiorrespiratória em adolescentes. Métodos: Trata-se de uma revisão sistemática, relatada seguindo as recomendações de redação do PRISMA, sem restrição de idioma, para artigos indexados nas seguintes bases de dados: MEDLINE / PubMed, Embase, Cochrane Library e Lilacs. A extração dos dados foi realizada de forma análoga em planilha previamente testada e padronizada. A avaliação do risco de viés nos estudos incluídos foi realizada pela ferramenta RoB 1.0 em todos os seus domínios em duplicata de revisores. Inicialmente, foram encontrados 3.039 estudos. Resultados: Os estudos abrangeram um total de 526 adolescentes de dez a 19 anos. A plataforma mais utilizada nos estudos foi o Nintendo Wii, seguido do PlayStation, Xbox 360 e Dance Dance Revolution. Os resultados indicaram que as intervenções com exergames foram eficazes para alterar o IMC, mas não houve evidências sobre os desfechos cardiovasculares, sem alterações eficazes no controle glicêmico e na pressão arterial e uma resposta significativa ($p < 0,05$) na aptidão cardiorrespiratória. Conclusão: O exergame aponta resultados satisfatórios na melhoria da saúde e pode ser incorporado como uma política pública relevante na promoção da saúde do adolescente. (Registro PROSPERO CRD42020181772). ***Nível de evidência II; Estudos terapêuticos: investigação dos resultados do tratamento.***

Descritores: *Exercício Físico; Vídeo Game Ativo; Adolescente; Saúde Pública.*

RESUMEN

Introducción: Los Exergames o videojuegos activos son plataformas digitales con funcionalidad asociada al movimiento corporal, que dialogan con la mejora de los niveles de actividad física, estimulando el placer en la práctica y la adherencia a cambios de hábitos, conducta físicamente activa y mejor calidad de vida. Objetivo: Este estudio tuvo como objetivo sintetizar la evidencia disponible sobre la contribución del exergame al índice de masa corporal, nivel de actividad física, control glucémico, presión arterial y aptitud cardiorrespiratoria en adolescentes. Métodos: Se trata de una revisión sistemática, reportada siguiendo las recomendaciones de redacción de PRISMA, sin restricción de idioma, para artículos indexados en las siguientes bases de datos: MEDLINE / PubMed, Embase,

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Cochrane Library y Lilacs. La extracción de datos se realizó de manera similar en una hoja de cálculo estandarizada y probada previamente. La evaluación del riesgo de sesgo en los estudios incluidos se realizó mediante la herramienta RoB 1.0 en todos sus dominios por duplicado de revisores. Inicialmente, se encontraron 3.039 estudios. Resultados: Los estudios abarcaron un total de 526 adolescentes de 10 a 19 años. La plataforma más utilizada en estudios fue la Nintendo Wii, seguida de la PlayStation, Xbox 360 y Dance Dance Revolution. Los resultados indicaron que las intervenciones con exergames fueron efectivas para cambiar el IMC, pero no hubo evidencia sobre los resultados cardiovasculares, no hubo cambios efectivos en el control glucémico y la presión arterial, y una respuesta explicativa (p <0.05) en la aptitud cardiorrespiratoria. Conclusión: El exergame muestra resultados satisfactorios en la mejora de la salud y puede ser incorporado como una política pública relevante en la promoción de la salud de los adolescentes. (Registro PROSPERO CRD42020181772). ***Nivel de evidencia II; Estudios terapéuticos: investigación de los resultados del tratamiento.***

Descriptores: *Ejercicio Físico; Videojuego de Ejercicio; Adolescente; Salud Pública.*

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INTRODUCTION

The American Sports Medicine Association (ASMS) recommends that children and adolescents' practice 300 minutes of physical activity per week, being divided into at least 60 minutes of daily activity for 5 days a week.[1] However, these individuals end up failing to reach this minimum time of physical activity, being considered as physically inactive,[2-4] increasing their predisposition to obesity and chronic non-communicable diseases (NCDs).[5-7] The practice of physical activity when performed regularly, corroborates with the improvement in cardiorespiratory performance, physical fitness,[8] mental and social health,[9,10] both instantly and in the long term.[11,12]

Consequently, sustainable and effective strategies for increasing levels of physical activity are important for adolescents, as it is considered as a phase of transition into adulthood and for a period of constant physical, mental and social change.[13] Thus, the persistence in healthy habits and the practice of regular physical activity can be fundamental and reflect a healthier adult life.[1] In this section aimed at teenagers, it is believed that exergames (EXG) / active video games can be a strategy for changing habits and practicing physical activity.[14]

EXG platforms are synchronized by motion sensors with joysticks or cameras so that users perform body movements and are transmitted to the game screens to achieve their goals within the game,[15,16] demonstrating to be a possible solution for young people. With the use of active video games, the practice of physical activity can become more attractive and be the ideal tool for stimulating habits and increasing energy expenditure.[17]

Therefore, there is a need for scientific evidence on the context of EXG as promoters of physical activity and benefits for changing habits, effective as an improvement strategy for inactive behaviors and health problems. This systematic review aims to summarize the available evidence of the exergame on body weight, level of physical activity, glycemic control, blood pressure and cardiorespiratory fitness of adolescents, favoring decision-making.

METHODS

The writing of this research was developed according to the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes - PRISMA[18] report and the methods guided by the Cochrane Handbook for Systematic of Interventions v. 5.0 (https://training.cochrane.org/handbook). This study is characterized as a systematic review of randomized clinical trials and is registered prospectively in the International Prospective Register of Systematic Reviews (PROSPERO) under registration number CRD42020181772 and appears as completed.

To search for the studies to be included in this systematic review, a strategy based on Evidence-Based Practice (EBP) was used, ordered by PICOS, which is an acronym for Population (P), Intervention (I), Comparison (C), Outcomes (O) and Study Design (S). Thus, the study search and selection strategy was ordered as follows: P: adolescents between ten and 19 years old with inclusion when divided by age groups, of both sexes, regardless of health status; I: exercises interceded by EXG, disregarding studies of game development and game platform; C: Sham comparator (do not receive intervention) or active comparators (resistance, aerobic exercise, etc.); O: 1st: body weight measured in kilos (kg), 2nd: systolic and diastolic blood pressure (SBP / DBP) measured by sphygmomanometer, oscillometric meter or by outpatient basis , physical activity level (PAL) measured by Long IPAQ or accelerometry, glycemic control measured by glycated hemoglobin (HbA1c) or fasting blood glucose or casual blood glucose, cardiorespiratory fitness measured by direct (ergospirometry) or indirect tests (6-minute walk test); S: Randomized clinical trial, regardless of publication status, language and methodological quality in humans.

The research was directed with an ultra-sensitive search in four electronic databases - Medline, Cochrane Library, Embase and Lilacs until May 2020. It was restricted to studies in humans without any language limitation, using combinations of words such as: Exergame [Mesh] and synonyms; Exercise [Mesh] and synonyms; teenagers [Mesh] and synonyms; Body Weight [Mesh] and synonyms. The complete search strategies can be found in the appendices, with reference to each database.

This review used randomized clinical trials that evaluated the effectiveness of EXG in adolescents who obtained an intervention group and a control group. After the results of the searches in each database, all were imported into the EndNote software (Version X6), in which eventual duplicates were removed automatically and later by visual inspection, arriving at a final list of studies to be tracked.

Two reviewers (EVP and JMF) independently examined the titles and summaries of relevance through EndNote for exclusions. When there was no consensus among reviewers, a third reviewer (LH) was consulted for adjudication. When it was no longer possible to exclude texts by titles and abstracts, we proceeded to read the full texts (JMF and EVP) according to the eligibility criteria, reaching the final number of texts to be summarized in this review. In case of divergences, the same procedure for titles and abstracts was adopted.

The excluded studies were designated for folders with the reasons for exclusion, following hierarchical order by: studies that were not carried out with humans; studies that were not randomized clinical trials; studies that were not carried out with adolescents in the age group stipulated by the present review; studies that did not evaluate cardiovascular outcomes and studies that did not use exergame as an intervention.

The data extraction was performed in the same pattern as the studies, ordered by two reviewers independently and triggering a third one in cases of disagreement in the extraction. It was performed on a standardized table and tested before official extraction, the items extracted were: a) title of the text; b) magazine; c) country; d) year of publication; e) age group; f) percentage of men in the sample; g) system (game model used in the study; example: Xbox, PS3, etc.); h) exergame (system game, example: Sonic, Sports, etc.); i) training mode (interval / continuous, aerobic / anaerobic); j) duration in weeks (intervention time); k) weekly frequency (days); l) number of participants (intervention and control); m) description of the activities carried out in the groups (intervention and control); n) training intensity and volume; o) evaluation methods; p) number of dropouts / excluded from the study; r) supervision of professionals during the execution of the intervention; s) primary and secondary outcomes; t) extraction of results; u) evaluated comorbidities; v) if the authors had a conflict of interest; w) registration of a clinical trial.

Risk of Bias

The risk of bias in the primary studies was assessed using the Cochrane Collaboration Risk 1.0 (RoB 1.0) tool, with the criteria available in the Cochrane Handbook for Systematic Reviews of Interventions version 5.0. This process was carried out in duplicate (LH and EVP) and only the final decision was verified (that is, decisions of "potentially yes" and "yes" that do not change the direction of the algorithm were considered equal, the same being true for "potentially no"" and not"). All tool domains were used and reported. After closing in agreement by peers, the final data was imported into the Review Manager 5.4.1 (RevMan) software for quantitative estimation and elaboration of an illustrative figure.

RESULTS

Protocol deviation

This systematic review deviated from its protocol while driving in relation to its primary outcome, which was previously total body weight and has now become the Body Mass Index (BMI). The reason for this was due to the low prevalence of studies on using body weight (and preference for BMI) in their outcomes. The change history can be viewed in our registry under number CRD42020181772.

Main Results

Through the search in the databases, using the respective search strategy, 3039 studies were initially located. Through the EndNote X6 program, duplicates were excluded and 2062 studies remained. The reviewers independently selected all titles and abstracts identified by EndNote X6. After first reading 2026 studies were considered ineligible and divided into folders for exclusion reasons, in addition to the duplicate exclusions that appeared after the automatic exclusion and were made visually.

Thus, 36 studies in full text analysis were analyzed as potentially eligible. From these, 31 studies were excluded for not meeting the eligibility criteria (different design, age range outside the stipulated by the study, evaluation methods), ending in five studies to be synthesized.[19-23] The flowchart for selecting studies is shown in Figure 1.

As for the sociodemographic data, the studies cover a total of 526 adolescents. All included adolescents, two studies did not reveal participants' comorbidities,[20,22] one study evaluated children and adolescents with autism[19] and two articles evaluated overweight and obese adolescents.[21,23] Regarding gender, only one study included a 100% female sample,[21] the other studies included both genders, two with a higher percentage for men[19,20] and two with a higher percentage for women.[22,23] (Table 1)

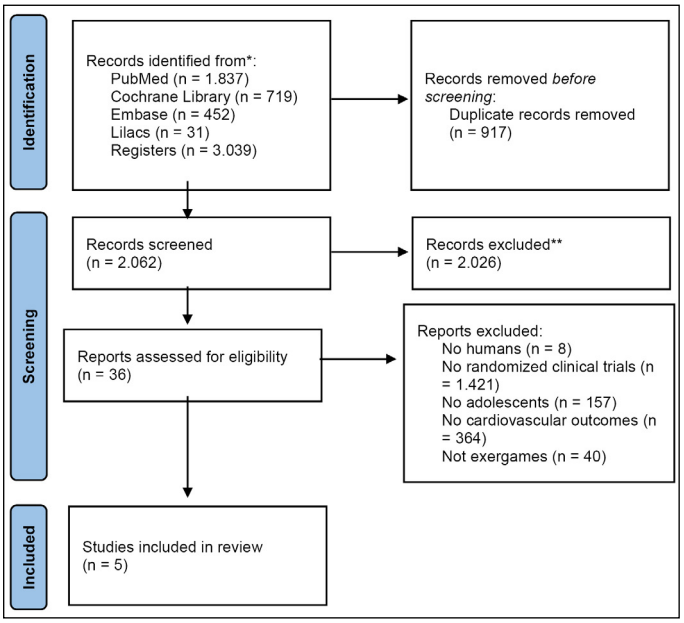

Figura 1. Process flow and identification, screening, eligibility and inclusion of studies in the systematic review.

With regard to exposure, the intervention groups held training sessions three times a week in three studies,[19,21,23] the others performed the intervention once a week[20] or acutely in a single moment.[22] The execution time varied from 15 to 75 minutes. Regarding the evaluations of the control group, they differed between physical education classes twice a week,[19] or maintaining two normal activities,[23] two studies did not make it clear in the study what were the activities developed by the control group[20,21] and the study that evaluated the acute form had a 30-minute session.[22] (Table 1)

The most used platform in the study was the Nintendo Wii,[19,22] followed by the PlayStation,[20] Xbox 360[21] and Dance Dance Revolution.[23] The exergames exposed in this study were: Mario and Sonic at the Olympics, Sports (Nintendo Wii), Just Dance and Dance Central (Xbox 360), Dance Dance Revolution, Sport Champions, Move Fitness, Start the Party and Medieval Moves, Dance Star Party and Sorcery (PS3 and PSMOVE). (Table 1)

Table 2 shows the main results found in this systematic review, stratified as exposed by the authors of the respective studies. The results show different measures from each other because each study used a different method of evaluation, they are specified in the table.

Risk of Bias

Generally speaking, in sum with all domains that demonstrate low risk of bias, the values are higher for this classification than for high risk or unclear risk, except for the risk of bias for selective reports. However, we describe the frequencies for low risk of bias, unclear risk of bias and high risk of bias, respectively: a) selection bias due to the random draw of participants: 60%, 20% and 20%; b) selection bias, under the pretext of hiding data allocation: 40%, 40% and 20%; c) performance bias: 40%, 40% and 20%; d) detection bias: 60%, 40% and 0%; e) friction bias: 60%, 20% and 20%; f) reporting bias: 20%, 20% and 60%; and g) other bias: 80%, 0% and 20%. The complete assessment of the risk of bias is shown in Figure 2.

DISCUSSION

This systematic review sought to synthesize the effects of exergame in adolescents on the evidence related to its possible benefits in BMI, level of physical activity, glycemic control, blood pressure and cardiorespiratory fitness in five studies. The results indicated that after EXG there

Table 1. Main characteristics of the included studies.Note: no study has declared a conflict of interest; only the study by Staiano et al., (2017) registered a clinical trial under number NCT02003963 and by Simons et al., (2015) under number NTR3228.

	Sample				Exposure		
Study	**Randomized**	**Analysed**	**Age Sex (%)**	**Comorbidities**	**Intervention**	**Control**	**Platform/Exergame**
Dickinson; Place,[19] 2014	Int.: 50 Cont.: 50	Int.: 50 Cont.: 50	5-15 Years 79% boys 21% girls	Autism	15 min/day, 3 times a week for 40 weeks Circuit modes	2 routine physical education, de 30-45 min	Nintendo Wii/ Mario and Sonics at the Olympic Games
Staiano et al.,[21] 2017	Int.: 22 Cont.: 19	Int.: 20 Cont.: 18	14-18 Years 100% girls	Overweingh and obesity	60min/day, 3 times a week for 12 weeks Aerobic, continuous	-	Kinect® Xbox 360®/ Just Dance (v.3;4 2014, e Greatest Hits) Dance Central (v. 2;3).
Wagener et al.,[23] 2012	Int.: 21 Cont.: 20	Int.: 20 Cont.: 20	12-18 Years 33,3% boys 66,7% girls	Obesity	1° session: 75 min 4:15min Next sessions: 40 min 2:15min, 3 times week for 10 weeks Aerobic, interval	Routine physical education for 10 weeks	Dance Dance Revolution
Simons et al.,[20] 2015	Int.: 140 Cont.: 130	Int.: 50 Cont.: 134	12-17 Years 91% boys 9% girls	-	60 min/day, 1 time week, for 40 weeks Aerobic, interval	-	PS3, PS Move/ Sport Champions, Move Fitness, Start the Party e Medieval Moves, Dance Star Party e Sorcery
Staiano; Calvert,[22] 2011	Int. A: 25 Int. B: 24 Cont.: 25	Int. A: 25 Int. B: 24 Cont.: 25	12-18 Years 39,19% boys 60,81% girls	-	Grupo A: 30min Grupo B: 30 min Aerobic, interval	30min/session	Nintendo Wii/ Sports (TENNIS)

Caption: Int.: Intervention; Cont.: Control; min: minutes; E.F: physical education; n.a: did not evaluate; v .: version; PS3: PlayStation 3; PS: PlayStation. All results were extracted as presented by the authors.

Table 2. Measures of overweight / obesity and cardiovascular outcomes assessed in the included studies.

Study	**Outcome pre**		**Main Results**			
			post			
	Primary	**Secundary**	**Intervention**	**Control**	**Intervention**	**Control**
Dickinson; Place,[19] 2014	PF	VO_2máx. BMI Power of LL, agility, resistance AS FACES IV	BMI†: 20,1(6,1) Beep test†: 3(4) Shuttle run†: 92(27)	BMI†: 20,2 (5,6) Beep Test†: 2(3) Shuttle run†: 84,5(49)	BMI †: 19,8 (5,6) Beep test†: 4,5(5) Shuttle run†: 68(43)	BMI †: 21,5 (5,5) Beep Test†: 2(2) Shuttle run†: 90(42)
Staiano et al.,[21] 2017	Body composition (BMI, WC, BF, BMD) FRC (total cholesterol, tryglicerides glucose, insulin, HDL-C e LDL-C)	Feasibility of the intervention	IMC (m/DP %): 97,4(2,9) SBP (m/DP %): 63,5(25,2) DBP (m/DP %): 60,9(22,3) Glucose (m/DP mg/dL1): 87,6(6,4) Insulin (m/DP µUmL1) 24,2(15,2)	BMI (m/DP %): 97,1(3,3) SBP (m/DP %): 56,6(30,1) DBP (m/DP %): 66,4(20,5) Glucose (m/DP mg/dL1): 91,8(21,8) Insulin (m/DP µUmL1): 19,4(10,4)	BMI (m/DP %): -0,1 (0,2)# SBP (m/DP %): -13,3 (6.3) # DBP (m/DP %): -3,8 (4.8) # Glucose (m/DP mg/dL1): 1,5(6.5) # Insulin (m/DP µUmL1): 1,9(2.2) #	BMI (m/DP %): 0,1 (0,2) # SBP (m/DP %): -1,75 (6,4) # DBP (m/DP %): -7,70 (4,9) # Glucose (m/DP mg/dL1): 11,61(6,7)# Insulin (m/DP µUmL1): 4,07(2,2) #
Wagener et al.,[23] 2012	BMI (*z-score*)	PCS BASC-2 PRS-A SRP-A	BMI (mean/DP): 3,15(0,19)	BMI (mean/DP): 3,15(0,20)	BMI (mean/DP): 3,13(0,18)	BMI (mean/DP): 3,12(0,20)
Simons et al.,[20] 2015	BMI-SDS CC CQ SDC	TTS CBA	BMI-SDS (m/DP): 0,48(1,2)	BMI-SDS (m/DP): 0,35(1,1)	BMI-SDS (m/DP): 4M 0,51 (1,2) 10M 0,49(1,1)	BMI-SDS (m/DP): 4M 0,33(1,0) 10M 0,28(1,0)
Staiano; Calvert,[22] 2011	GET BMI	Pleasure for the activity	GET-JRSxAR (kcal): 66,72 (8,61) GET-VxJSV (kcal): 70,03 (8,43)	GET-JRSxAR (kcal): 66,72 (8,61) GET-VxJSV (kcal): 70,03 (8,43)	GET-SxAV (kcal): 54,83 (11,74)	GET-AS (kcal): 37,69 (11,85)

Note: †: Interquartile range by median; #: results after described by change with intention to tartar; PF: Physical fitness; VO2max: maximum volume of oxygen; BMI: Body Mass Index; LL: lower limbs; AS: abdominal strength; FACES IV: scales for assessing family cohesion and adaptation; WC: waist circumference; BF: body fat; BMD: bone mineral density; FRC: cardiovascular risk factors; GCT: total body fat; TAT: total adipose tissue; SBP: systolic artery pressure; DBP: diastolic blood pressure; HDL-C: high intensity lipoprotein; LDL-C: low intensity lipoprotein; PCS: scale of perceived competence; BASC-2: Behavior Assessment System for Children - 2; PRS-A: Parents' Rating Scales - Adolescent version; SRP-A: Adolescent Self-Report Scales; m / SD: mean / standard deviation; BMI-SDS: body mass index adjusted for mean and standard deviation; WC: waist circumference; CQ: hip circumference; SDC: sum of skin folds; TTS: sedentary screen time; CBA: consumption of drinks and sugars; GET: energy expenditure; GET-JRSxAR: tennis game energy expenditure in real situation vs real opponent; GET-VxJSV: solitary energy expenditure vs voluntary vs virtual opponent; GET-SxAV: solitary energy expenditure vs virtual opponent; GET-AS: sedentary activity energy expenditure; kcal: kilocalories; m / SD: mean / standard deviation; cm: centimeter; mm: millimeter. The results present different evaluation measures because each study obtained a different evaluation method. All results were extracted as presented by the authors.

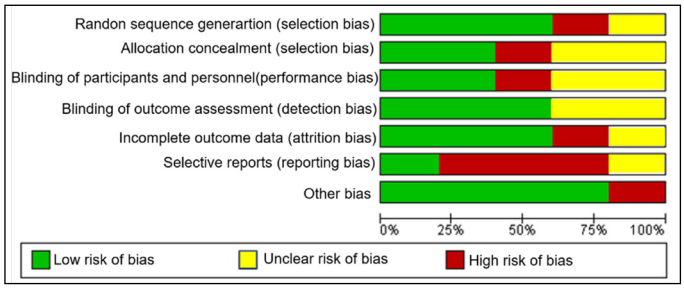

Figura 2. Assessment of risk of study bias in the systematic review.

were improvements such as reduced body fat, changes in BMI values, and changes in cardiorespiratory fitness outcomes.

Systematic reviews prior to this study assessed the effects of EXG on some of our assessed outcomes.[24-26] Our primary outcome obtained responses related to changes in BMI values with exergames. All results showed modifications, therefore, significant results were mixed, Dickinson & Place,[19] Staiano et al.,[21] and Wagener et al.[23] did not demonstrate significant values. Simons et al.[20] and Staiano & Calvert[22] obtained significant values in this variable.

In the syntheses carried out by other authors, Hernández-Jiméniz et al.,[24] in their review and meta-analysis when evaluating the impact of exergame on BMI found significant results. The study by Norris et al.,[27] on the other hand, found no significant differences in BMI values related to the practice of exercise interceded by EXG. Ramírez-Granizo et al.,[26] reported that interventions with EXG were more effective than traditional activities in reducing BMI, but activities by active video games were not enough to change the levels of physical activity.

Betz et al.,[28] when assessing the association between BMI, physical activity and blood pressure with young people aged 8-18 years, found that obese young people had higher BP compared to other eutrophic young people. In this study, there was also a combined and independent association between physical activity and BMI in BP ($p < 0.001$), in line with the statements of Poeta et al.[29] in which there is a great importance in reducing fat and BMI values to reduce the risk of cardiovascular disease.

As for the outcome related to glycemic control, it is known that physical exercise is considered one of the best alternatives for the treatment and aid in the control of blood glucose levels in patients with diabetes melittus. Lima et al.[30] in their results obtained a reduction in the initial blood glucose levels, in addition to obtaining a correlation with the levels of glycated hemoglobin and the BMI z-score. Data that corroborate with those found in this SR, which, despite not showing significant values for analyzes by intention to treat, obtained changes in clinical values.[21]

In this study, assessments related to adolescents' cardiorespiratory fitness were performed using the beep test and shuttle run. The measures reported significant values in the intervention and control groups, and in the difference between groups with EXG, it showed superiority to the control group,[19] demonstrating a positive impact of EXG on the physical fitness and quality of life of the adolescents evaluated.

Ye et al.[31] explored the long-term effects with EXG intervention in 4th grade (elementary) students at a school based on physical activity and cardiorespiratory fitness behaviors, the children in the intervention group, obtained an increase in their level of physical activity, reduced the time of sedentary activity from 815.59 minutes to 788.81 minutes and the time of moderate physical activity went from 74.99 minutes to 89.41 minutes, and the control group also obtained time reductions in all results 832.73 min to 809.27 minutes in sedentary activities and 48.69 to 64.08 minutes of vigorous physical activity.

The strengths of this systematic review were the ultra-sensitive search strategy, with no restrictions on dates and languages, which enabled the previous reading of many studies in the literature. International standards for the development of systematic review, where most of the decisions made during the review (readings, data extraction, tables and inclusion and exclusion criteria) were developed in duplicates in order to minimize possible errors. The use of more than one health indicator in relation to the practice of exercises with exergames, demonstrating a broader result in the relationship of EXG in the health of adolescents.

Limitations

The main limitation related to this study was the low number of studies related to the use of EXG for the purpose of assessing the level of physical activity and its contributions to health for adolescents. Also, as a result of this fact, because the systematic review covers few studies, thus, the heterogeneity of the studies did not make it possible to perform a meta-analysis, and makes it difficult to generalize the findings reported to adolescents. In addition, the studies have small and often non-significant samples in the outcomes on the level of physical activity, which possibly be the result that none of the studies found performed the minimum time of 300 minutes a week of physical activity indicated by the WHO.

Future directions

As future directions, new studies on these outcomes are indicated, including other types of studies, such as cross-sectional studies, for example. These studies were not included in this review because the purpose was to assess the effectiveness of physical exercise interceded by exergames for cardiovascular outcomes and BMI. In addition, the authors of this study intend to develop their own digital platform as a strategy to increase levels of physical activity and behavior change aimed at the health of adolescents and thus assess its effectiveness in practice.

CONCLUSION

EXG suggests satisfactory results, and in its synthesis, they present changes in evaluated variables, in some of lesser magnitude. It should also be emphasized that it may be a relevant strategy for incorporating public policy into health promotion, especially aimed at school-age adolescents, when additional evidence confirms our findings and assesses their feasibility, with a predominance of low-risk studies of bias in different domains, suggesting reliability in the findings found.

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