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Effects of dancing on physical activity levels of children and adolescents: a systematic review

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ABSTRACT

Background: Dancing has been suggested to increase the levels of physical activity of the youth. However, it is not clear what are the physiological characteristics of the dance classes for young people, mainly regarding the levels of moderate to vigorous physical activity (MVPA) during classes. It is also unclear if regular engagement in dance practices can contribute with increases in the amounts of daily/weekly MVPA, recommended by health organizations.

Objectives: To conduct a systematic review verifying the amount of time spent at MVPA (primary outcome), by children and adolescents in the following situations: i) During dance classes, and ii) Before and after dance interventions. Secondary outcomes included: markers of exercise intensity during class, such as oxygen consumption (VO_2) and heart rate (HR); VO_2peak and lipid profile before and after dance interventions.

Methods: Six data sources were accessed (MEDLINE, EMBASE, Cochrane Wiley, PEDRO and SCOPUS). Study selection included different designs (acute, cohort, randomized controlled trials and others). Participants were from 6 to 19 years old, regularly engaged in dance practices. Methodological quality was assessed using the Downs and Black checklist. Two independent reviewers extracted characteristics and results of each study.

Results: 3216 articles were retrieved, and 37 included. Studies indicated that dance classes do not achieve 50% of total class time at MVPA. However, there are peaks of HR and VO_2 during dance classes, which reach moderate and vigorous intensities. MVPA/daily/weekly did not improve before and after dance interventions for most of the studies, also VO_2peak did not. The few results on lipid profile showed improvements only in overweight and obese participants.

Limitations: Lack of meta-analysis, because there were not enough articles to be analyzed on any given outcome of interest, neither under the same study design.

Conclusions: Results of individual studies indicated that dance classes did not active 50% of the total time at MVPA levels. This may be related to the absence of improvements in daily/weekly MVPA before and after dance interventions. VO_2 and HR attained peaks of moderateto vigorous intensity during dance classes, suggesting that the structure of the classes may be manipulated to maintain longer periods at MVPA levels. Lack of data on cardiorespiratory fitness and metabolic outcomes limit conclusions on these parameters.

Implications of Keys Finds: Considering there are peaks of HR and VO_2 during dance classes, we suggest that the structure of a dance class can be manipulate in order to induce cardiorespiratory and metabolic adaptations. Thus, dancing is a potential strategy to contribute with a healthy life style since the earliest ages. Prospero registration: CRD42020144609

1. Introduction

Levels of physical activity (PA) of children and adolescents have been decreasing worldwide.[1] In accordance with the World Health Organization (WHO), 81% of the individuals in between 11 and 17 years old do not reach 60 min of moderate to vigorous physical activity (MVPA) levels per day.[1] This is the amount of MVPA recommended by the American College for Sports Medicine (ACSM) to proper develop

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aerobic fitness and cardiometabolic health in the youth.[2] More recent data have shown a reduction in the percentage of children (6–12 yrs old) who perform exercise at least 3 times a week (from 28,3% in 2012 to 23, 9% in 2017, respectively).[3]

These increases in sedentary behavior during childhood and adolescence, impact on general levels of physical fitness and health-related parameters.[1,4,5] Indeed, cardiorespiratory fitness, flexibility, muscular resistance and power, have been associated with reductions in PA through the lifespan.[1,4,5] Along with that, changes in diet behavior plus sedentary life style leads to an accumulation of adipose tissue, just based on the fact that energy expenditure is lower than energy intake. [6] As a result, increased risks for developing hyperlipidemia, insulin resistance, type II diabetes mellitus (T2DM), obesity and other metabolic disorders, are early established.[7,8] As a matter of fact, these are chronic conditions that contribute to all cause of cardiovascular mortality in adult life. [7,8] In this context, physical inactivity has been suggested as a major health public problem of the XXI century.[9] It has been related to 13,2% and 10,8% of the causes of deaths in Brazil and USA, respectively.[10]

In fact, studies have shown a significant interaction between reduced levels of PA and increased risk for developing cardiometabolic diseases in children with low cardiorespiratory fitness.[7,11] On the other hand, increases in the level of low intensity PA have been associated with improvements in diastolic blood pressure, insulin resistance, lipid profile, waist circumference and body fat percentage in children and adolescents.[12,13] Also, MVPA have been directly associated with reductions in cardiovascular risk, which is mediated by substantial increases in cardiorespiratory fitness.[7,12,14,15]

Physical activity guides, such as the ACSM, WHO and Nacional Physical Activity Plan Aliance (NPAPA),[1,2,5] recommend a minimum of 60 min/day of MVPA, which may be split in two or more exercise bouts a day. PA levels of intensity are classified as sedentary behavior, light (57–63% HRmax), moderate (64–76% HRmax), moderate to vigorous (64–95% HRmax), and vigorous (77–95% HRmax). = Sedentary behaviour is defined by the time sitting, reclining or lying down, as well as any waking behavior that spent less than 1.5 metabolic equivalents (METs). [16,17] Additionally, it is recommended at least three days a week for resistance and flexibility training.[5]

In particular, dancing has been suggested as a potential strategy to increase the amount of daily general levels of PA in children and adolescents[18–20]. It is an activity of entertaining, performed in group, leading to feelings of satisfaction and success. [21] Indeed, engaging personal and social factors are reported to increase motivation and adherence to exercise interventions.[22] Following that, improving skills such as balance and coordination, [23] may stimulate the young ones to be more physically active in different social environments, thus contributing for a healthier life style. [19] As dancing is widely practiced as a leisure activity among the youth, it should be investigated as an alternative way for preventing overweight, obesity and other cardiovascular risk factors associated with sedentary behavior.[24,25] Nevertheless, it is not clear what are the physiological characteristics of the dance classes for young people, mainly regarding the levels of moderate to vigorous activity during classes. Furthermore, it is not known if regular engagement in dance practices can contribute with increases in the amounts of daily/weekly MVPA, recommended to develop cardiorespiratory fitness and cardiometabolic health along with the growth process.[2,5]

Therefore, the goal of this systematic review was to verify the amount of time spent at MVPA (primary outcome), by children and adolescents, in two different situations: 1) During dance classes, and 2) Before and after dance interventions. Secondary outcomes analyzed during dance classes were the following markers of exercise intensity: oxygen consumption (VO_2), heart rate (HR), lactate and METs. Secondary outcomes analyzed before and after dance interventions were: peak oxygen consumption (VO_2peak) and lipid profile (triglycerides, total cholesterol, high and low density lipoprotein cholesterl - HDL-C and LDL-C). Different study designs were included (observational, pre-post, randomized and non-randomized trials), in order to identify the acute (during dance classes) and chronic (before and after dance interventions) effects of dancing on the selected variables. For this reason, this review included studies with and without comparison groups.

2. Methods

This study was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement.[26] This review was prospectively registered at PROSPERO (CRD42020144609).

2.1. Search strategy and study selection

The following electronic databases were searched for articles published from the earliest to September first, 2018: Medical Literature Analysis and Retrieval System Online MEDLINE (accessed by Pubmed), Excerpta Medica database (EMBASE), Cochrane Wiley (Central Register of Controlled Trials), and Physiotherapy Evidence Database (PEDRO). In addition, the reference lists of relevant published studies were searched manually. To identify relevant publications, the combined search terms (exploded versions of the Medical Subject Headings [MeSH]) were used: (Child OR Children OR Preschool children OR Dancer, Young Dancer OR Elementary school children) AND (Dancing OR Dance OR Dance Therapy OR Hip Hop Dance OR Jazz Dance OR Aerobic Dance OR Zumba OR Latin Dance OR Fun Dance). Other terms included can be found in the full search strategy, available as supplementary data (Supplementary material 1).

2.2. Eligibility criteria

We included studies which reported the practice of dance as a structured and/or regular activity of children and adolescents from 6 to 19 years of age (or mean age inferior to 17 yrs), with and without overweight. Different study designs were included, such as: cross-sectional, cohort, acute, pre-post studies, randomized and non-randomized controlled trials (RCT and nRCT). Acute studies were considered the ones that analysed the outcomes of interest only during dance classes. Studies published in English, Spanish and Portuguese language were considered. Studies assessed for eligibility included any style of dance, such as: Ballet, Jazz, Hip Hop, Foxtrot, Swing, Aerobic dance, Contemporary/Modern dance, Mambo, Cha-cha-cha, Meringue, Afro, Latin, Tango, Waltz, High Kick dance, and Traditional dance. Dance practice should be performed at dance studios, gyms, competition, school environments and/or outside. Studies analysing dance video game only, or dancing at nightclubs, were excluded. Studies involving patients with neurodegenerative diseases, eating disorders, and/or muscle-skeletal injuries were also excluded.

2.3. Data extraction

Titles and abstracts of retrieved articles were independently evaluated by two investigators. Abstracts that did not provide enough information about the inclusion and exclusion criteria were submitted to full evaluation. Two reviewers independently evaluated full text articles, determined study eligibility, and conducted data extraction. Disagreements were solved by consensus or by a third reviewer. The following characteristics of individual studies were extracted: dance style, duration of follow-up, intensity of the sessions, age and gender of participants, specific outcomes of interest and its methods of assessment. Amount of time at MVPA (min or % of the total dance class), VO_2, HR, lactate and METs during dance classes, were extracted from all experimental designs which had the description of the dance session. Amount of time at MVPA (daily and/or weekly min); before and after dance interventions, were extracted from RCT, nRCT, and pre-post study designs.

2.4. Study quality assessment

Study quality was assessed using the Downs and Black criteria, a 27-item instrument designed for evaluating different study designs.[27] A maximum score of 32 points could be obtained from five quality domains: (1) reporting (10 items, 11 points); (2) external validity (3 items, 3 points); (3) internal validity (bias assessment, 7 items, 7 points); (4) confounding assessment, 6 items, 6 points); and (5) power (1 item, 5 points). Responses were scored and summed to produce subscales and a total score, with higher scores indicating higher quality. The instrument has a high internal consistency (Kuder-Richardson Formula 20:0.89), acceptable inter reliability ($r = 0.75$), and good test-retest reliability ($r = 0.88$).

2.5. Data analysis

A qualitative un-weighted analysis was performed for the outcomes of interest. It included a detailed descriptive analysis of each study, as well as considerations and perspectives from the panorama of the research in the area. Pooled-effects estimates could not be performed under a meta-analysis, because there were not enough articles to be analyzed on any given outcome of interest, neither under the same study design.

3. Results

3.1. Study selection

From 3470 potentially relevant citations identified through electronic database searching, 3216 records were screened (after removing duplicates) and 74 full text articles were assessed for eligibility. After that, 37 articles were excluded due to the following reasons: 3 studies presenting combined intervention; 5 studies using a dance video-game protocol; 12 studies not contemplating the age of the participants; 10 studies evaluating outcomes of no interest; 4 studies consisting of other types of publication: books, guidelines, conference abstracts, etc.; and 3 studies with no authors' reply. Finally, 37 studies were included in the systematic review (Fig. 1).

3.2. Overview of studies

The thirty seven studies included in this systematic review presented the following study designs and outcomes: Twelve acute studies[28–39]: seven evaluating HR,[28,31,32,35–38] four Lactate,[28,36–38] five MVPA/class,[29,30,33,34,39] and three VO_2.[36–38] Seven cross-sectional designs [40–46]: four evaluating VO_2,[40,41,45,46] three HR,[40,41,46] one general levels of PA[43] and one METs.[44] Five pre-post studies [25,47–50]: two analysing MVPA/-class,[47,50] three MVPA/weekly,[48–50] two general levels of PA,[25,49] one HR,[25] one lipid profile[25] and one METs.[49] Four cohort[19,51–53]: one analysing VO_2,[51] two METs,[51,53] two HR[19,52] and one MVPA/class.[19] Four RCT [20,54–56]: four evaluating general levels of PA,[20,54–56] one MVPA/daily,[54] one MVPA/class,[55] two MVPA/weekly[20,56] and one lipid profile.[56] Four nRCT[57–60]: one evaluating MVPA/ daily,[57] three VO_2,[57–59] one PA,[57] two HR[58,60] and one MVPA/class.[60] One cross over design [61] evaluating MVPA/class. See Fig. 2.

3.3. Characteristic of participants and interventions

Participants of the included studies were children and adolescents in between 6 and 19 years old. The number of participants ranged from 8 [42] to 1211, [44] from the smallest to the largest study. Participants were engaged in dance practice in dance studios, during competitions or in the laboratory. Four RCTs, [20,54–56] five pre-post,[25,47–50] four nRCT [57–60] and one cross over [61]study analyzed participants submitted to dance interventions elaborated only for research purposes. Control groups maintained their usual lifestyle (regular physical education class or free

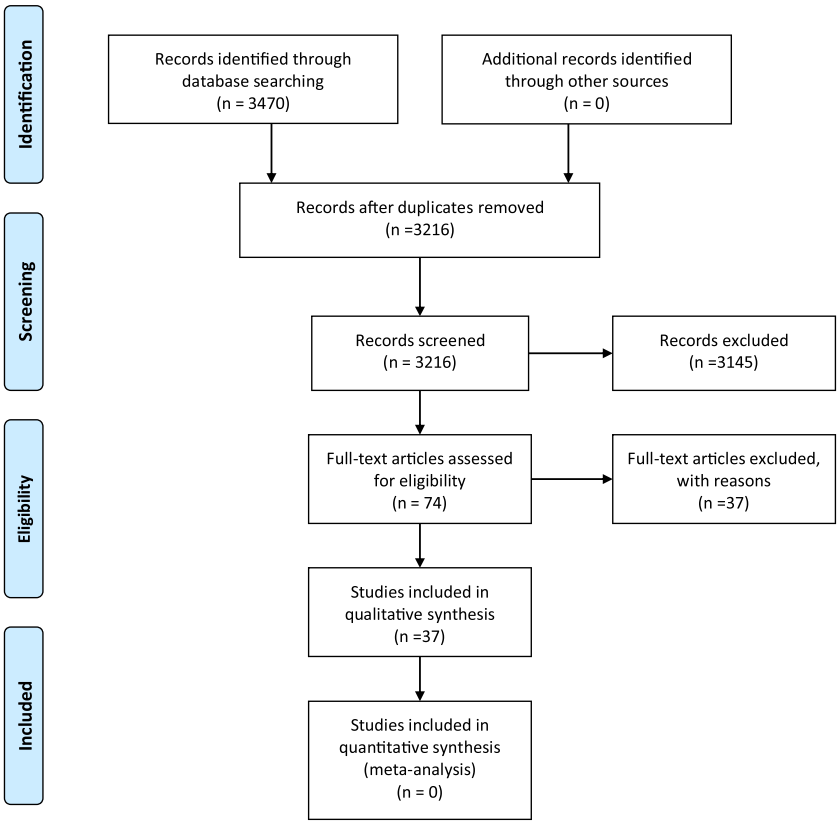

Fig. 1. Flow Diagram of studies included in the systematic review.

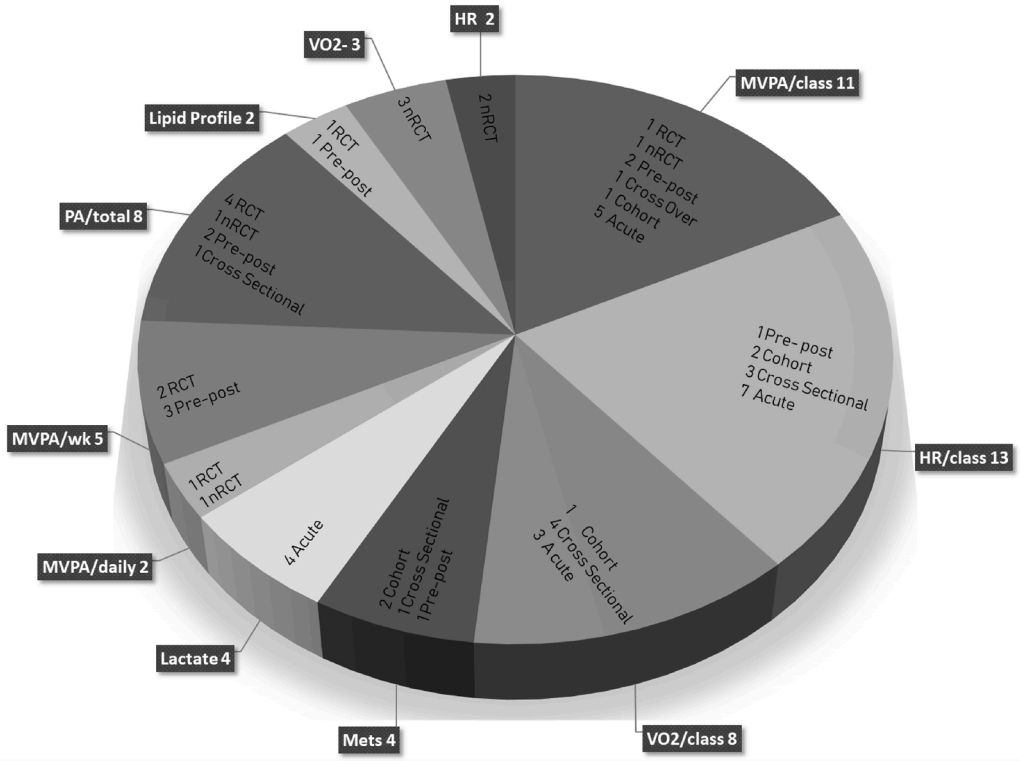

Fig. 2. Overview of the outcomes and studies design included. Diagram displaying the number of studies evaluating each outcome of interest, and their respective experimental designs. MVPA/class: time spent at MVPA during dance classes. MVPA/daily: Time spent at MVPA per day, before and after dance interventions. MVPA/weekly: time spent at MVPA per week, before and after dance interventions. PA/total: general PA time, before and after dance interventions. HR/class: Mean HR during a whole dance class and/or dance sequence, rehearsal, competition. VO_2/class: mean VO_2 during a whole dance class and/or dance sequence/rehearsal/competition. Mets: Mets achieved during a dance class, and/or before and after dance interventions. Lactate: levels of lactate during dance classes, and/or pre-post dance class/ sequence/rehearsal/competition. VO_2: VO_2 before and after dance interventions. HR: heart rate before and after dance interventions. Lipid profile: total cholesterol and/or LDL-C, HDL-C, and triglycerides before and after dance intervention.

play time), and/or were engaged in health educational programmes.

Dance protocols included different dance styles, such as: Ballet,[29,30,33,34,36,37,40,41,43,45,46,52,53] Jazz,[29,30,33–35,43,45,55,59] Aerobic dance,[49,51,58,61] Cha-cha-cha,[25] Hip Hop,[25,34,43,48,50,54–56] Swing,[19,25,30,32] Meringue,[19,30,32] Afro,[54,56] Tango,[19,32] Waltz,[32] Foxtrot,[19,32] High Kick,[28] Highland,[31,42] South Asian,[52] Flamenco,[30,34] Salsa,[30,34,35,50,57] Tap dance,[29,30,33–35] Ballroom,[30,34] Dance,[20,32,39,44,45,62] Mambo,[25] Jump Jam,[47] Line dance,[35,50,60] Rumba,[32,50] Cheerleading,[50] Modern,[50] Folk,[45] and Samba.[57] The minimum frequency of the sessions was 2x/wk, considering RCTs, nRCT and pre-post studies. The length of the interventions varied from 3 wks [23] to 2 yrs .[44] Duration of the dance sessions was in between 30[49] and 75[20] min. Detailed description of participants, intervention and outcomes assessed are in Table 1 (for cross-sectional, cohort and acute studies), and Table 2 (for RCT, nRCT, pre-post and cross over studies).

3.4. Primary and secondary outcomes

3.4.1. During dance classes

3.4.1.1. Time at moderate-vigorous physical activity. Regarding the level of PA at different intensities during dance classes, studies showed that young people remained the majority of the time at light PA levels and/or and sedentary behaviour. [19,30,33,34,47,55] Time spent at MVPA during dance classes varied from 5.5% to 85.2% [35,39] of the total class time. During a 60 min class, the dance styles that remained longer at MVPA were: Swing (22.3 min), [30] Hip Hop (26.9 min), [30] Jazz (22.1 min),[30] and Ballroom (30.1 min).[19] Specifically, sedentary time during dance classes varied from 6.4 [55] to 14.5 min [33]; light intensity PA from 11.9 [30] to 49.4 min [33]; moderate intensity from 4.8 [33] to 19.5 min [30]; vigorous intensity from 2.2 [30] to 7.3 min [30]; and moderate-vigorous intensity from 4 [32] to 30.1 min. [19] There was one study in which all participants remained dancing at least 30 min at MVPA intensity.[19] See Table 3 and Fig. 3.

3.4.1.2. Exercise intensity markers. During dance classes, mean HR values varied from 117 to 172 bpm, [19,25,28,31,32,35] depending on dance style and situation. For instance, Baille et al. (2007)[31] presented mean HR values of 151, 172.6 and 195 bpm for Highland dance class, rehearsal and competition, respectively. The same study showed increases in lactate levels (mmol.L^{-1}) in between the first (1.4) and the last dance (7.3) during the competition. Similarly, Rice et al. (2018)[28] showed lactate levels increased from 1.55 to 8.6 mmol.L^{-1} after the performance of a High Kick dance sequence. VO_2 values (by indirect calorimetry) during a Ballet class were similar to the ventilatory threshold of ballet dancers with different technical levels (16–19 mL.kg^{-1}. min^{-1}).[37] Trost et al. (2016) [51] found VO_2 values of 17.6 mL.kg^{-1}. min^{-1}, equivalent to 3.9 METs, during an aerobic dance class. Also, Harrel et al. (2003)[44] showed that dance achieved 5 METs, using a physical activity checklist. See Table 1 and Table 2.

3.4.2. Before and after dance interventions

3.4.2.1. Time of moderate to vigorous daily /weekly physical activity. General levels of PA were assessed in 21 articles,[19,20,25,29,30,33,34,39,43,44,47–50,53–57,60,61] Overall, studies showed an increase in the general levels of PA of children and adolescents who

Table 1
Characteristics of the studies (cohort, cross-sectional and acute) included in the systematic review.

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
Aujla (2015) Cohort 2yrs	Female students from the UK Centres for Advanced Training nationwise govemment-funded talent development programmes in dance, 10–18yrs n = 367	Contemporary, Ballet, South Asian and Urban dance	Regular dance class at the advanced Training Centres	Number of Adhering (AD) and Dropout students (DP) PA (h/wk) %HRmax at stage 3 and 5 of DAFT	Dropout (n:87) 3.38 h/wk %HRmax stage 3 (Represents class demands): 80 %HRmax stage 5 (Represents performance demands): 92 Adhering (n: 280) 3.57 h/wk %HRmax (stage 3 and 5): 81 and 93 * Physical factors did not have a great influence on adherence and dropout among young talented dancers.
Huang (2012) Cohort 10wks	Children from public elementary schools, from New York 8–11yrs n = 82	Ballroom: Swing, Foxtrot, Tango and meringue	Arts-in-education dance program, taught by professional Ballroom dance teacher	% of class time walking and Very active MVPA during class (min and %) Mean HR during class (bpm) % of class time at $\geq$ 25% HRR	47% of class time walking and 43% very active 30min of class time in MVPA, whats represent 60% of the total time Mean HR during class was 117 bpm Being 69% of class time spent above 25%HRR * Ballroom dance achieve levels of PA recommended by Healthy People 2010 (50% of class time at MVPA)
Matthews (2006) Cohort 3yrs	Childrens, Melbourne, Australia. 8–11yrs n = 509	Ballet	Group 1: dancers -Regular dance class at schools of classical Ballet n = 275 Group 2: non-dancers - Regular activity n = 234	Total Hours of PA per week PA (METS/wk)	Dancers (n = 64) PA: 7.6 h/wk METS: 42 mets/wk Non-Dancers (n = 50) PA: 3.2 h/wk METS: 33 mets/wk * Dancers have greater number of total weight bearing activity hours and METS per week than non dancers.
Baldari (2001) Cross-sectional	Young female postmenarcheal, classified as elite Dancers, gymnastics and sedentary, from Italy 13–16yrs n = 32	Ballet	All three groups (dancers, gymnastics and sedentarys) were submited to a laboratory test for fitness Dancers (n = 12) Sedentary (n = 12) Gymnastics(n = 8)	VO_2(mL.kg^{-1}.min^{-1}), HR (bpm) and Lactate(mmol.L^{-1}) at: Maximum Effort(ME) Ventilatory Threshold (VT) Anaerobic Threshold (AT)	Maximum Effort (VO2, Lactate and HR): Dancers 48,7.5,195 Gymnastics 52,9.0,201 and Sedentary 35,6.2,197 Ventilatory Threshold (VO2, Lactate and HR): Dancers 21.7,2.4, 161. Gymnastics 30.8, 2.1,138. Sedentary 15.6, 2.2, 135 Anaerobic Threshold (VO2, Lactate and HR): Dancers 30.5,4.0,183. Gymnasctics 43.8, 4.0, 164. Sedentary 20.6, 3.9, 158 * VO_2max was similar between gymnasts and dancers, however values of VO_2 at VT and AT were able to discriminate the higher level of fitness in gymnasts
Clarkson (1985) Cross-sectional	Young dancers from ballet companies, 12–17yrs n = 13	Ballet	Laboratory test for fitness	VO_2(mL.kg^{-1}.min^{-1}) and HR (bpm) at Maximum Effort	VO2max: 48.9 mL.kg^{-1}.min^{-1} HRmax: 200 bpm * Ballet dancers have VO_2max values below the average for elite endurance athletes
Craig (2010) Cross-sectional	Young female dancers from the Stirling Higlan Dance Company, Oakdale 10–17yrs n = 8	Highland dance	2 hour class, performed individually at the laboratory	Mean lactate (mmol.L^{-1}) after a dance class	Sweat levels o lactate after a 2 hours class: 20.4 mmol.L^{-1} * Correspondent to 0.7 mmol.L^{-1} of lactate levels in plasma
Da Rosa (2018) Cross-sectional	Students from an elementary school 7–11yrs, Santa Catarina-BR n = 200	Ballet, Jazz and Hip Hop	Group 1: Physical education and dance as extracurricular activity (PEDP) n = 50 Goup 2: Only physical education (PE)	screen time (h/day) PA level: sedentary or active	PEDP: screen time was 3.88 h/day, and 100% of children were classified as active PE: screen time was 5.12 h/day, and 79% of children were classified as active

(*continued on next page*)

Table 1 (*continued*)

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
			n = 150 Physical Education class = 45 min - 3x/wk		* PEDP have higher PA level and less sedentary behavior
Harrel (2003) Cross-sectional	Children and adolescents from schools of rural countries in North Carolina 11–14yrs n = 1211	Dance	Leisure time activities: talking, running, soccer, dance, bicycling and others. Girls (n = 659) boys (n = 544)	Percent reporting the activity Estimated MET	17% of girls and 0.2% of boys reported dance METS: Dance -5, talking - 2, running - 8, bicycling -5 and soccer -8 * Dance was classified as moderate intensity, like bicycling.
Opstoel (2015) Cross-sectional	Childrens who participated in the flemish sports compass, involved in a lest one sport, from Belgium 09–11yrs n = 620	Ballet, Modern, Folk and other dances	Sports participation : badminton, korfball, soccer, artistic gymnastics, dance and others. Girls (n = 273) Boys (n = 347)	Absolute values of the physical fitness measure endurance shuttle run (min)	Sport (n) - SRmin: Korfball (3) - 7.5, badminton (4) - 3.88, soccer (163) - 6.11, artistic gymnastic (38) - 5.37 Dance (54) - 5.89 Ballet (19) - 5.74 Folk dance (6) - 3.83 Jazz (13) - 5.04 Modern dance (19) - 4.11 * Children at young ages did not present sport-specific physical characteristics, except the ones with a high volume of training.
Pekkarinen (1989) Cross-sectional	Young boys, dancing for a least 4 years, with mean time spent on dance class of 4h/wk 9–16yrs n = 27	Ballet	Laboratory test for fitness Prepuberal (n = 13) Puberal (n = 14)	VO_2(mL.kg^{-1}. min^{-1}) and HR (bpm) at Maximum Effort	Prepuberal: VO2max - 47 mL.kg^{-1}.min^{-1} and HRmax - 192 bpm Puberal: VO2max - 56 mL.kg^{-1}.min^{-1} and HRmax - 199 bpm * Prepuberal dancers showed lower VO_2max than cross country and controls (data for another study[72]). Pubertal dancers presented lower values than cross country athletes, but similar to controls.
Trost (2016) Cohort 3yrs	children and adolescents, from Oregon 6–16yrs n = 209	Aerobic dance	At least 5 min for each activity: lying down, comfortable over-ground walk, basketball, aerobic dance and etc.	Activities intensity: VO_2mL.Kg^{-1}.min^{-1} and METS	Age group: trial (n) - VO_2(mL.kg^{-1}.min^{-1}) and METS: 6–8yrs: Lying Down (40) - 7.3 and 1.2, Comfortable over-ground walk (41) - 20.7 and 3.7, Basketball (41) - 41 and 6.2 Aerobic dance (42) - 18.2 and 3.3 13-16 yrs: Lying down (67) - 5.0 and 1.3, Comfortable over-ground walk (67) - 15.4 and 4.0, Basketball (68) - 30.4 and 7.8 Aerobic dance (71) - 16.5 and 4.3 * Lying down was considered sedentary activity, Aerobic dance and Comfortable over-ground walk were defined as moderate, and basketball as vigorous intensity. Also VO_2 declined with age, for each activity.
Baillie (2007) Acute	Female Championship Competitors 14yrs n = 9	Highland	3 situations: Class, Rehearsal and Competition (three dances: Highland Fling, Sword dance and Sean Truibhas, 2–3 min each, 50 sec. break in between)	Values of Lactate (mmol. L^{-1}) after the perfomance of the three dances mean HR(bpm) of each dance Mean Values of HR (bpm) for the 3 situations	Competition: nºDance - mean HR, lactate levels pre –> post 1st Dance - 194, 1.4 –> 4.5, 2^{sd} Dance - 196, 2.3 –> 6.9 and 3th Dance - 194, 3.5 –> 7.3 Mean HR (bpm) from: Competition: 195, Rehearsal: 172 and Class: 151 * Recovery time during competition is insufficient. Also Exercise intensity during class is lower than the other conditions; indicate the primary use of aerobic metabolism. However during competition

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Table 1 (*continued*)

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
					the values were near maximal, showing predominance of anaerobic metabolism.
Cain (2015) Acute	Students girls from private dance studios and from community centers, California 5–18yrs n = 264	Ballet, Jazz, hip-hop, Latin-Flamenco (Latin-F), Latin-Salsa and Ballet Folklorico (Latin-SBF), tap, and partnered dance (Ballroom, Meringue, and Swing).	Regular dance class at dance studio Children (n = 154) Adolescents (n = 110)	% and min of total dance class at: sedentary, light, moderate, vigorous and MVPA for children and adolescents Min of dance class at MVPA for private schools and community centers	Group (All dances): (minutes) Light and MVPA; (%) light and MVPA Children: 2.77 and 5.60; 3.36 and 6.42 Adolescents: 1.62 and 1.67; 1.68 and 1.75 Private studios accumulated 5.3 and 4.9 minutes of MVPA for children and adolescents respectively, and Community centers 6.9 and 8.0. * Children are more active than adolescents in all type of dance, except for Ballet. Latin -F was the least active dance and Hip Hop and Ballet were the most active from children and adolescents respectively.
Froberg (2017) Acute	Children, from Sweden 7–14yrs n = 149	Dance	39 lessons co-education Physical Education (dance, fitness and others)	Mean %MVPA during class	%MVPA during class range from 4 to 33 for girls and 6 to 37 for boys, in dance and fitness respectively. * Fitness training, ball games and orienteering were the lesson who provide more MVPA volume. The Lower MVPA volume can be explained by characteristics of dance class like instructions and demonstrations of a stop and go nature.
Guidetti (2007) Acute	Female adolescents dancers, post menarche, attending private dance schools,from Rome, Italy 13–15yrs n = 12	Ballet	30 minutes of dance exercises (25 *tour piqués* on full pointe) under two condition with and without warm up. And fitness tests, the two testing session were perfomed individualy at the laboratory Warm up: 3 min running (25–35%VO_2max), 15 min stretching (10–20%VO_2max)	VO_2 during 30 min of *piqué tour,* with and without warm up Contribution of different metabolic sources in % of overall energy cost, during both situation	VO_2: 38 mL.kg^{-1}.min^{-1}, with warm up and 37 mL.kg^{-1}.min^{-1}without warm up Warm up (% of 38 mL.kg^{-1}.min^{-1}): 26 Aerobic, 56 alactic and 18 lactate Without Warm up (% of 37 mL.kg^{-1}.min^{-1}): 39 aerobic, 50 alactic and 11 lactate * Warm up did not affect the overall energy cost, decrease the percentage contribution of the anaerobic source, and increased the aerobic sources contribution during the exercise.
Guidetti (2007) Acute	Female adolescents, post menarcheal, attending to technical program of classical Ballet grade 5, in private dance schools, from Rome, Italy 13–6yrs n = 39	Ballet	Typical Ballet class (70 min) performed individually. **[A]** 34 min: *Barre* exercises (*pliés, battements tendus, ronds de jambe à terre*, etc). **[B]** 23 min: Center-floor exercises (*pirouettes 2 tours, temps levé, grand adage.*etc). **[C]** 13 min: On full point (*relevé echappé, pirouette, tours piqué endedans,* etc.*)* Group 1: Low technical proficiency (n = 13) Group2: intermediate technical proficiency (n = 14) Group 3: High technical proficiency (n = 14)	VO_2(mL.kg^{-1}.min^{-1}) and Lactate (mmol.L^{-1}) from different Ballet class sequences according to 3 technical levels	All three groups performed most of exercise above anaerobic threshold (more than 20, 24 and 27 mL.kg^{-1}.min^{-1} for group 1, 2 and 3 respectively) *Temps levés* and *pique tours* sequence show highest intensities for all groups (more than 30 ml.kg^{-1}.min^{-1} and lactate levels above 6 mmol.L^{-1}) * No differences were observed between groups. Jumps and exercises on full point were of high intensity for all three groups. The class was harder for the low technical level dancers who more often performed exercises above the anaerobic threshold.
Guidetti (2008) Acute	Female adolescents, post menarcheal, attending to technical program of classical Ballet grade 5, in private dance schools, from Rome, Italy 13–16yrs n = 25	Ballet	Individual performance of a center exercise: *grand adage* on pointe . Warm up (5 min): *pre barre* and *plié. Grand adage* (210s): *pliés, développés, dégagés, grand rond de jambe, rond de jambe en l'air, coupés, battements tendus, attitudes, arabesques, preparations for pirouettes, and pirouettes.* Group 1: Low technical proficiency, training 4h/wk (n = 13) Group 2: High technical proficiency , training 10–12h/wk (n = 12)	VO_2 (mL.kg^{-1}.min^{-1}) during *grand adage* Contribution of different metabolic sources in % of overall energy cost, during *grand adage* for both groups	Overall VO_2 (mL.kg^{-1}.min^{-1}) of grand adage: 81 and 94 for groups 1 and 2 respectively Group 1 (% of 81 mL.kg^{-1}.min^{-1}): 65 Aerobic, 23 alactic and 12 lactate. Group 2 (% of 94 mL.kg^{-1}.min^{-1}): 77 Aerobic, 18 alactic and 4 lactate. * Overall energy requirement of grand adage was not different between two groups. Aerobic sources were predominant for both groups. However, high technical levels performed the exercise around

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Table 1 (*continued*)

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
					their anaerobic threshold, and the low technical level dancers performed above.
Laurson (2008) Acute	Students participate in state-man- dated physical education on all school days, from Illinois. 14–18yrs n = 796	Line dance, Jazz, Tap, Salsa, Aerobic dance, etc.	Participation in various types of physical activities (fitness :cross-country run... Team: ultimate frisbee... and individual: golf, dance...) (30 min) Girls (n = 373) Boys (n = 423)	Mean values of HR and % HRmax during physical activities % of time spent above 50% of HRmax from all three activity types	Dance (n = 56): 124bpm and 85.2% Cross-country run (n = 48): 157bpm and 90.6% Ultimate Frisbee (n = 66): 130bpm and 68.4% Golf (n = 46): 101bpm and 43.7% Time spent above 50% of HRmax: Fitness 81.7%, Individual 68.4% and Team 60.6% * Fitness activities improve more values of HR. All types of activity spent more than 50% time class at MVPA, recommended by Health People 2010.
Lopez (2015) Acute	Children and adolescents, classified as introductory dance levels, from Southern California 5–18yrs n = 291	Ballet, partnered dance, private Jazz/hip-hop, Latin-Flamenco, Latin-Salsa/Ballet Folkloric, and Tap.	Dance class at private and public dance studios **[A]** Warm up: stretches, sit ups... **[B]** Technique: demonstrating moves and working on dance moves... **[C]** Routines: performance dance... **[D]** Fun: freestyle dance... **[E]** Break: resting and water... **[F]** Cool Down: stretching, squats, crunches...	Percent of segment class in MVPA and Sedentary during class	Warm up: 37 and 38; Technique: 35 and 29; Routine: 44 and 19; fun: 53 and 48; break: 29 and 45; Cool down: 60 and 31 * PA during dance classes differed by class structure and dance type. Routine and technique have longer duration than other segments. Also routine had a higher proportion of MVPA than did technique.
O'Neill (2012) Acute	Young Girls from a dance studios in Columbia 11–18yrs n = 137	Ballet, Jazz, and Tap	Dance class at studios (241 classes) Warm up: preparatory activities; Progressions dance steps; choreography: rehearsing a dance routine	Time (min) spent at: Sedentary, light, moderate, vigorous and MVPA during dance class %of class time spent at: Sedentary, light, moderate, vigorous and MVPA during dance class	All classes (Ballet, Jazz and tap): PA levels min and % Sedentary: 13.2 and 18.2; Light: 42.6 and 65.5; Moderate: 6.2 and 10.0; Vigorous: 4.2 and 6.3 MVPA: 10.4 min and 16.3% * Girls engaged in approximately 10 minutes of MVPA per hour of dance class participation. Dance alone cannot provide the recommended levels of PA (60 min MVPA/daily)
Nelson (2011) Acute	students from public elementary schools, recorded as eutrophic, overweight and obese by BMI scores, from Texas 11yrs n = 96	Meringue, Fox Trot, Rumba, Tango, Swing, Waltz, Fun dance	Dance class at school (2 classes) Girls (n = 50) Boys (n = 44)	Mean HR (bpm) of total class time Time (min) spent at the mean HR during class Time (min and %) spent above 60%HRmax during class	Dance style: HR (bpm) and time (min) Meringue: 122 and 4.1 min; Fox trot: 119 and 4.8; Rumba: 119 and 4.4; Tango: 120 and 4.5; Waltz 118 and 5.1; Swing: 143 and 3.4Fun Dance: 128 and 5.7 Children spent 47% (17.39 min) above the 60% HRmax * Dancing classrooms program is a physical education activity that can elicit a moderate cardiovascular response in fifth-grade participants. Meringue show HR response just above the specified threshold level, whereas Fun dance and Swing raised HR responses into a more vigorously HR range.
O'Neill (2011) Acute	Young Girls from a dance studios in Columbia 11–18yrs n = 101	Ballet, Jazz, Tap	Dance class at studios and PA during the day for 8 days	Time(min) spent at light, moderate, vigorous and MVPA during class % of contribution of PA intensities during dance class for the daily PA MVPA (min/day) during dance days and non dance days	Minutes at dance class: Light 39.4, moderate: 4.4, vigorous: 2.7 and MVPA: 7.1 Dance class % contribution for daily PA: light: 15.4, moderate 26.7, vigorous 39.6 and MVPA: 28.7 Program days: 28.7 min/MVPA/day Non Program days: 16.4 min/MVPA/day * Dance classes contributed with 29% of total weekly MVPA, and girls accumulated 70% more MVPA and 8% less sedentary behavior on dance class days than on non-dance class days.
Rice (2018) Acute	Competitive High Kick precision girls dancers, with a minimum of 1 year	High Kick	testing session : 45 min of a high-kick–specific drill	Lactate levels (mmol.L^{-1}) pre and post High Kick	Lactate levels increase from 1.5 to 8.6 mmol.L^{-1} after session

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Table 1 (*continued*)

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
	weight lifting experience, and participating in junior varsity or varsity dance team, from Minnesota 12–17yrs n = 137		Warm up: 25 jumping jacks, 10 arm circle, 3 frog jumps...more 10 min of dynamically stretch High Kick specific :2 sets of 8 ; butt kicks, straight kicks, right and lefth corner kicks, right and lefth fans, straight kicks, right and left greenies, etc.	session HR (bpm) mean and peak of a High Kick session	HR peak : 207bpm Mean HR (bpm): 172 * Transient bout of kicking has shown to result in substantial HR responses and increases in blood lactate concentrations, indicating that maximal aerobic capacity was most likely challenged for a majority of individuals.

practice dance. For example, increases of 40% in daily levels of PA were found after 16 wks dance intervention (45 min sessions, 3x/wk), which was concomitant to decreases in 30% for the time spent watching television.[25] Specifically for MVPA levels, there was no significant increments after 12 wks dance intervention (3x/wk) for Alhassan et al. (2.5–3.1%) [54] and Olvera et al. (64–71 min).[57] Similarly, Jago et al[20] did not show significant increments in weekly MVPA/weekdays after 20 wks of dance intervention, performed 2x/wk (75 min), and after one year of follow-up (from 53.25–57.69 and to 56.55 min, respectively). Robinson et al. (2010)[56] also did not find differences at MVPA/yr after 2 yrs dance intervention (60 min sessions, 5x/wk). There was only one study showing an increase in vigorous PA/wk, after 12 wks dance intervention.[49] Also, adding on regular dance classes to the routine of adolescent girls increased 28.7% their daily amounts of MVPA, when compared to their routines without dance classes.[29] See Table 2.

3.4.2.2. Cardiorespiratory fitness and lipid profile. Four studies[4957–59] evaluated different variables related to cardiorespiratory fitness as a result of dance interventions for children and adolescents. Flores et al. (1995) [58] showed improvements in resting HR (83 to 72 bpm) for girls after 12 weeks dance intervention (50 min sessions, 2x/wk). Thompson et al.[49] did not found increases in estimated VO_{2peak} (from 36.9–36.8 $mL.kg^{-1}.\ min^{-1}$) after 12 wks intervention (30 min session, 1x/wk). Gallota et al.[59] found improvements in the one mile test only for rural, but not urban dancers after 8 wks dance intervention (60 min sessions, 2x/wk). Olvera et al[57] demonstrated improvements in the number of laps of the 20-meter shuttle run test from pre (14.2) to post (20.7) dance intervention.

Three articles [25,4256] were found investigating biochemical markers in children and adolescents involved in regular dance activities. Improvements in TC (15,421 ± 30,05–148,2 ± 29 mg/dL), glucose (9255 ± 7,21–90,76 ± 6,53 μmol L^{-1}) and Non-HDL-C (1066 ± 2705–10,183 ± 2615 mg/dL) were found after 16 weeks of extra-curriculum dance classes (3x/wk) in children with overweigh and eutrophic body mass index.[25] Reduction in the ratio TC/HDL-C (4,01 ± 0,99 – 3,63 ± 1,02 mg/dL) and LDL-C (1025 ± 2592 – 9144 ± 2141 mg/dL) were found only in obese children (percentile ≥ 95th). Robson et al. (2010)[56] showed reductions in the percentage of individuals with high levels of -total cholesterol, LDL-C and insulin (5.2 %, 5.1 % e 11.1 %, respectively) after 2 yrs of dance intervention (5x/wk). In the same study, increases in HDL-C levels (6.7 %) were observed. See Table 2.

3.5. Study quality assessment

From the thirty seven studies assessed, quality scores varied from 10 points[58] to 29.[20] Greater scores mean higher methodological quality.[27] The average score was 17 points (52% of 32 points in total), which was deemed to be of moderate quality by consensus of the authors (Table 4).

Overall, the major weaknesses among studies were: Reporting of adverse events (described in only 1 study).[20] External Validity: representative population, study sample and source population (identified in 5 studies).[36,37,47,56,59] Internal Validity: randomization and process description, blind measures of main outcomes (reported in 7 studies),[20,38,47,54–56,58]. Power: Only six studies [20,36,37,52,56,59] reported power analyses (≥80%). Studies were more successful in meeting quality criteria for the categories of reporting (in the methods section) and results description . For example, 34 studies,[19,20,25,28–4547,48,51–61]described properly the aims of the study, outcomes analysed, characteristics of participants and interventions. Also, results were properly displayed as means and standard deviation or confidence interval. See Table 4.

4. Discussion

This systematic review primarily aimed to verify the amount of time

Table 2
Characteristics of the studies (RCT, nRCT, pre-post and cross-over) included in the systematic review.

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
Alhassam (2018) RCT 12wks	African-american or black overweight and non-overweight girls and their mothers, from Springfield, MA 7–10yrs n = 32 pairs	African, Jazz, hip-hop	Group 1: child and mother n = 14 Group 2: child alone n = 12 Group 3: control n = 6 All groups: health snacks and homework tutoring (120 min, 3x/wk) Extra: during the intervention mothers and daughters (off all groups) receive newsletters with the history of the dance style, and its impact on the african american culture. (1x/wk) Group 1 and 2: Dance intervention: two routines for each dance style design by: **[a]** warm up: 2 min; **[b]** Dance movements:8 min at MVPA; **[c]** cool down: 1 min (60 min, 3x/wk)	% of daily PA level (sedentary and MVPA...) Pre and post intervention for all three groups	Group: pre-post % daily PA (sedentary and MVPA, respectively) Group 1: 60.5 - 63.7 and 2.9 - 2.8 Group 2: 63.1- 57.9 and 2.5 - 3.1 Group 3: 57.3 - 55.2 and 3.3 - 3.5 * The intervention activities did not lead to statically significant changes in total daily PA levels.
Burkart (2017) RCT 12wks	African-american or black girls and their mothers, from Springfield 7–10yrs n = 76 pairs	African, hip-hop, and Jazz	Group 1: child and mother n = 28 Group 2: child alone n = 25 Group 3: health education program n = 23 All groups : healthy snack and homework tutoring (60 min) Group 1 and 2 participated in cultural lessons: african-american women in history spotlight, culturalties to dance (15 min, 1x/wk) Group1: 60 min of dance class at MVPA, 3x/wk (mother and daughter) Group 2:daughter attend: 60 min of dance class at MVPA, 3x/wk and mother participated of health education program weekly Group 3:participated of health education program and received newsletter at home, weekly	Time (min) spent at sedentary, light and MVPA, during dance classes from children	Time (min) spent at sedentary, light and MVPA, respectively Group 1 (mother and daughter): 9.1, 34.1 and 10.8 Group 2 (only daughter): 6.4, 41.1 and 11.1 * Group 2 spent less time being sedentary and more in MVPA than group 1. Mother-daughter interventions have shown minimal effects in increasing pa levels.
Jago (2015) RCT 20wks	Girls, from somerset and Bristol city 11–12yrs n = 508	Dance	Group 1: Dance n = 254 75min, 2x/wk Group 2: control n = 270	Mean weekday MVPA (min) at baseline, 20 wks and 1 year follow up for both groups	Mean weekday MVPA (min), before and after 20wk intervention: Dance : 53.25–>57.69 Control: 49.15–>60.46 Mean weekday MVPA (min), 1 yrs follow up: Dance : 56.55 Control: 53.15 * After-school dance programme can increase the PA of girls
Robinson (2010) RCT 2 yrs	African american or black girls, overweight (and/or at least with 1 overweight parent/guardian (bmi≥ 25), from Oakland, California. 8–10yrs N = 243	African Dance, hip-hop and step	Group 1: Dance intervention and screen time reduction. 60 min: homework and small snack. 60 min: of dance class. Dance performances were performed every 8 wks for families and friends 5x/wk (with girls attending as often as they wished.) Screen time reduction: 24 lessons (during 2 yrs). Mentors met with families in their homes to delivery each lesson n = 126 Group 2: health education Culturally tailored information based health education on nutrition and PA for reducing cardiovascular and cancer risk. It included 24 monthly newsletters for the girls and their	Changes of total cholesterol (CT) and low density lipoprotein cholesterol (LDL) in mg/dl per year Changes of time spent at MVPA min/weekday, per year	Changes per year of CT, group 1 and 2, respectively: -7.35 and -4.18 mg/dl Changes per year of LDL, group 1 and 2, respectively: -3.90 and -1.06 mg/dl No statiscal diference was found in changes of MVPA min/weekday, per year * The dance and screen time reduction intervention provide clinical important changes in lipid levels, insulin levels, and depressive symptoms compared with health education.

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Table 2 (*continued*)

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
			parents/guardians n = 117		
Flores (1995) nRCT 12wks	Low-income african american and hispanic adolescents, from Los Angeles 10–13yrs n = 110	Aerobic Dance	Group 1: Dance oriented PA health education class n = 43 Warm up: 5 min, Aerobic dance: 40 min at mpva and cool down: 5 min (50 min,3x/wk) Health education curriculum (25 lessons): 10 min of didactic activity and 20 min with other types of activities about nutrition, exercise, unhealthy weight, stress management, etc. (2x/wk) Group 2: usual PA n = 38	Mean values of resting HR (bpm) pre and post intervention for both groups Mean values of time mile run (min) pre and post intervention for both groups	Resting HR (bpm) change from 84 to 73 for girls in the intervention group and maintained 79 in control group The timed mile run (min) changed from 14.8 to 13.9 in the intervention group and 14.6 to 14.1 in the control group for girls. There was no significant changes between intervention and control groups for boys * Dance for health has proved to be an effective program to improve fitness mostly in girls than boys
Gallota (2011) nRCT 6 months	Healthy female Modern Jazz Dancers beginners, from Rome 11–12yrs n = 44	Modern Jazz	Group 1: urban dancers n = 21 Group 2: rural dancers n = 23 Foundations of the Modern-Jazz dance style **a]** warm up: 25 min, strength and flexibily (5 omni rpe); **[b]** across-the-floor: 15 min, locomotor work across the floor (4 omni rpe); **[c]** choreographies: 30 min, learning of dance phrase combinations (3–5 omni rpe) (60 min, 2x/wk) Last 2 months of dance traning focus on the final dance exhibition	Time in seconds of 1mile run/ walk test	Rural dancers improved time in 1-mile run/walk test
Schroeder (2017) nRCT 2 yrs	Children and parents from west philadelphia. 2–79yrs n = 521	Dance	Group 1 : children n = 149 (2–21yrs) Group 2: adults n = 372 (21–79yrs) Dance for health sessions were offered weekly for one month in the spring and one month in the fall (8 wks total per year) from 2012 to 2016.	Number of steps during classes % of childrens and adults that active the target HR zone (50%hrmax) during class Borg (RPE) at the end of class	Children active 1999 steps and adults 2507 50.6% , 80.5% of children and adults, respectively, reached target HR during dance sessions. Borg RPE was “somewhat hard” and within the target range of 12–14 for children and adults * Adults and children both reached moderate to high perceived exertion rates, adults were more likely to reach target HR. This program was not sufficiently intense for children.
Hogg (2012) Pre-post 16wks	Children target as high risk group for obesity, eutrophic, overwiegth and obese, from New York 9–11yrs n = 61	Mambo, Cha-cha-cha, Hip Hop, Swing.	Only group Girls n = 39 Boys n = 22 Dance class : (45 min at 75%of HRmax) three times a week as a structured, child-friendly class and once a week as a practice session. (60 min,4x/wk) Interactive lifestyle education seminars for parents and children. Focus nutritional intake and PA (30 min, 1x/wk)	Mean HR(bpm) during class Resting HR (bpm) pre and post intervention Pre and post Mean values of glucose, low density lipoprotein and total cholesterol (mg/dl)	Mean HR during class was 130bpm Resting HR (bpm) decreased from 86 to 78 for children with different BMI Parameter: pre to post (mg/dl) Glucose: 92.55 to 90.76; LDL: 97.69 to 92.6 and TC: 154 to 148.2, changes for all BMI categories 40% increased PA and decreased of 30% screen time, at 18 wks follow up * The dance class active intensity considered MVPA that approaches aerobic threshold. Also, an improvement was seen in a variety of risk factors.
Romero (2012) Pre-post 5wks	Young mexican-american boys and girls, from US 11–16yrs n = 56	Hip Hop (break dance)	Only group Girls n = 37 Boys n = 19 10 dance sessions: 20 min: lesson content; 30 min: break dance; 5 min: group warm up; 10 min: group practice breaking moves (top rock, down rock and up rock); 10 min: individual praticipe and 5–10min: of group battle in circle (50 min, 2x/wk)	Frequency of vigorous PA according to questionary scores	Girls increased frequency of vigorous PA in dance, from 1.97 to 2.97 questioners scores * Hip Hop based dance intervention was an effective strategy to increase PA among Mexican-American adolescent girls in a low-income neighborhood.
Thompson (2013) Pre-post 12wks	Black or african american, from North Carolina 12–18yrs n = 41	Aerobic dance	Only group: F.u.n intervention PA, body image, cultural differences...(30 min, 1x/wk) Aerobic dance (30 min, 1x/wk)	Level of PA (wk) Vo2max (predicted by HR variation)	There was no increase in the levels of PA per week, but vigorous PA increased significantly. Increases in the level of PA were related to family support.

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Table 2 (*continued*)

Aythor (Year) Study Design	Participants	Dance Style	Intervention or Protocol	Outcomes and methods of assessment	Results and conclusions
					There was no change in aerobic capacity (36.8 mL. $kg^{-1}.min^{-1}$) pre – post * Girls with higher perceived support were more likely to have higher total METS than girls who had less perceived family support, but findings from this study were not statistically significant.
Olvera (2010) Pre-post 3wks	Overweight and obese african americans or latin girls, from Houston 8–14yrs n = 31	Rumba, Salsa, Hip Hop, Dance, Ballet, Cheerleading, Modern , Line dance	Only group Group sessions of exercise, nutrition education, and behavioral counseling for three weeks (from 9:am to 5:00pm, 5x/wk) 21 different physical activities with intensities between 2 or more mets (traditional fitness, dance, games, sports skills and flexibility) **[a]** 30 min: flexibility, **[b]** 60 min: sports skills or game. **[c]** lunch and nutrition lesson **[d]** counseling session **[e]** 60 min: dance Exercise session also included: 5 min of warm up , and 5 min cool down, at light-vigorous PA.	Time (min)spent MVPA/wk during three weeks % of girls attending MVPA guidelines during three weeks % of time spent in MVPA during specifics PA	MVPA (min/wk): week 1: 60.47; week 3: 74.70 %/wk attending MVPA guidelines: week 1: 66 and week 3: 63 MVPA %/activity: traditional fitness 32; Dance and games 21, sports skills 18 and flexibility 7 * Traditional fitness activities were the most effective in yielding the highest proportion of MVPA. However dancing and games sessions elicited significantly more MVPA than sports skills sessions
Olvera (2010) nRCT 12wks	Latino mother and daughters 7–13yrs n = 35 pairs	Salsa and Samba	Group1: experimental N = 18 Aerobic or sports or free play (45 min 3x/wk) Nutrition session (45 min, 2x/wk) Behavioral counseling session (45 min, 1x/wk) Group2: control N = 17 Nutrition education and counseling topics (45 min,1x/wk) Light intensity aerobic or sport: 45 min,1x/wk	MVPA min/day pre and post intervention 20 msr(number of laps) pre and post intervention PA and fitness for mothers: exercise hr(bpm), VO_2 mL. $kg^{-1}.min^{-1}$and PA rating	MVPA min/day for daughters pre and post: group 1:64 to 71 and group 2: 35 to 38 20msr (number of laps) for daughters pre and post: group 1: 14 to 21 and group 2: 11 to 13 No changes in physical fitness or self- reported PA levels for mothers in both groups * A significant statistical increase in physical fitness was observed in daughters participating in the group 1 compared to those in the group 2.
Kulinna (2018) Pre-post	Students from a elementary school in New Zeland 8–11yrs n = 192	Jump jam	Group 1: physical education lesson n = 88 Jump jam (aerobic program that combine dance and fitness): 35 min] Group 2: regular classroom work n = 104 Nonactive :reading and writing tasks	Number of steps and MVPA (min) during the 45 min of intervention for both groups % of time at MVPA in jump jam lesson (35 min)	Group 1: 1931 steps and 8:81 min Group 1: spent 25% of dance class at MVPA * The acute bout of Aerobic dance delivered during a regular physical education lesson permitted that students engaged in about 9 minutes of MVPA
Gao (2013) Cross over 9 months	Children from an urban public elementary school, from US 10–11yrs n = 53	Aerobic dance	Situation a:physical education class: Aerobic dance + other sports Situation b: physical education class: Dance Dance Revolution (DDR) + other sports Data collection: 15 min of Aerobic Dance and 15 min Dance Dance Revolution 30 min, 3x/wk	% of time at MVPA during 15 min of Aerobic Dance or Dance Dance revolution MVPA (min) during 15 min of Aerobic Dance or Dance Dance revolution	% MVPA during class: aerobic: 21 and ddr: 31 MVPA (min) during class: 4.66 and 3.16 at aerobic and DDR, respectively * Children exhibited more estimated MVPA time in Aerobic dance than they did in DDR.

Table 3
Time spent at different levels of physical activity during dance classes, and heart rate responses of different styles for children and adolescents between 7 and 18 years old.

Reference	ST (min)	LPA (min)	MPA (min)	VPA (min)	MVPA (min)	HR (bpm)	Dance Style
O Neill et al. (2012)	13.2	42.6 65.5 %	6.2	4.2	10.4		
Nelson et al. (2011)					47 %	124	
Hogg J. et al. (2012)						130	
Laurson et al. (2008)					85.2 %	124	***DANCE***
Cain et al. (2015)	12.8 26 %	14.7 30 %	15.2 32 %	5.4 12 %	20.6 44 %		
Froberg et al. (2017)					5.5 %		
Olvera et al. (2010)					21 %		
Lopez C. et al.(2015)					15.8		
Burkat et al. (2017)	6.4	41.1			11.1		
Cain et al. (2015)					22.3		***SWING DANCE***
Nelson et al. (2011)						143	
Cain et al. (2015)	9.1 19 %	11.9 24 %	19.5 42 %	7.3 15 %	26.9 57 %		***HIP HOP***
O Neill et al. (2012)	14.5	36.7	7.5	4.4	11.9		
Cain et al (2015)	11.4 23 %	13.5 27 %	16.1 34 %	5.9 14 %	22.1 48 %		
Cain et al. (2015)	13.1 27 %	15.8 33 %	15.9 33 %	3.5 7 %	19.2 40 %		***TAP***
O Neill et al. (2012)	14.5	36.7	7.5	4.4	11.9		
Cain et al. (2015)	15.0 30 %	19.0 40 %	11.6 25 %	2.2 5 %	13.9 30 %		***BALLET***
O Neill et al. (2012)	11.6	49.4	4.8	3.8	8.6		
Nelson et al. (2011)					4	122	***MERINGUE***
Nelson et al. (2011)					4.8	118	***FOX TROT***
Nelson et al. (2011)					4.4	119	***RUMBA***
Nelson et al. (2011)					4.5	119	***TANGO***
Nelson et al. (2011)					5.1	118	***WALTZ***
Nelson et al. (2011)					5.7	128	***FUN DANCE***
Cain et al. (2015)	11.2 23 %	14.2 30 %	15.3 33 %	6.2 14 %	22.3 47 %		***BALLROOM DANCE***
Huang et al. (2012)					30.1 59.79 %	118	
Baillie et al. (2007)						151	***HIGHLANG***
Gao et al. (2013)					31 %		
Kulinna et al.(2018)					8.81 25 %		***AEROBIC***
Cain et al. (2015)	26.9 55 %	14.2 31 %	3.6 9 %	2.3 5 %	6 14 %		***LATIN FLAMENCO***
Rice et al. (2018)						176	***HIGH-KICK***

ST: sedentary time, LPA: light PA MPA: moderate PA VPA: vigorous PA, MVPA: moderate to vigorous PA. Dance: term used for studies in which the authors did not report a specific style of dance, or when there was a mix of styles. Ballroom dance: included styles such as Swing, meringue, Tango and Foxtrot. Fun dance: dances that did not require a partner, such as the stomp, electric slide and cha cha slide. Intensity was described as the time (min) and / or percentage of time at sedentary, light, moderate, vigorous and MVPA. This table include only studies and styles that showed values described during dance class for time spent at MVPA (min or %). Mean HR (bpm) was also considered.

spent at MVPA, in children and adolescents engaged in dancing, under two different situations: 1) During dance classes, and 2) Before and after dance interventions. The main findings of this review indicated that during dance classes, children and adolescents did not meet the 50% of the total class time at MVPA, [29,30,33,34,39,47,50,55,60,61] which is recommended by the Centre for Disease Control and Prevention (CDC).[63] Following that, results from before and after interventions, suggested that dancing did not contribute significantly to increases in daily/-weekly MVPA. [20,48,54,56,57]

Dance classes have been often described to be performed at low aerobic intensities for several dance styles, [37,64] which supports our findings that there was not enough time spent at MVPA during dance classes. It seems that large amounts of time destined for learning and memorizing dance sequences, as well as performing them with correct style and technique, induces to constant drop downs in exercise intensity during dance classes. [64] This is particularly important considering young dancers, who are simultaneously developing physical and cognitive skills during their growth process. In fact, only 8% of the children and 6% of the adolescents remained more than 50% of the time of a dance class at the MVPA levels. [30]

Following that, there are some aspects which shoul be noted when analyzing the level of exercise intensity in dance classes. For instance, the use of accelerometers and pedometers to quantify PA levels in most of the studies, [29,30,33,34,39,47,50,55,60,61] may sub-estimate exercise intensity in dance. Dance involves exercises performed with the upper body, constantly moving trunk and arms, which are not quantified by this type of instruments. In fact, the use of arms increase cardiorespiratory demands, due to larger muscle mass involved during the exercise. [1,4] Another concern are the different cutoff points for MVPA levels adopted by different studies. Indeed, the only study in which all participants remained dancing at least 30 min at MVPA intensity,[19] used a cut-off point corresponding to only 25% of the HR reserve. In addition, dance style, teaching methodology, psychological tolerance, size of the dance studio, among other factors, may influence the level of PA during a dance class.

Our data showed that Ballroom[19], Hip Hop,[30] Jazz[30], and Swing[30] were the four dance styles that spent longer periods of time at MVPA during class (although not reaching 50% of the total class time). Considering Ballroom classes, they include styles like Swing and Meringue, which are characterized by fast songs, with very dynamic foot work (kicks and jumps). This possibly induces to higher levels of intensity. Differently, longer time at MVPA found in Hip Hop classes,[30]

Fig. 3. Time spent at MVPA during dance classes across different dance styles. This figure displays the time spent at MVPA in different dance styles. It is presented in a crescent order, from the shortest to the longest time at MVPA. Studies showed a range from 4 (low) to 30 (high) minutes at MVPA during dance classes. *Low: studies with 4−8 min at MVPA, Medium: studies with 8−29 min at MVPA, and High: studies with 30 or more min at MVPA (also studies with HR ≥ 151 bpm).*

may result from the way of teaching the dance routines. Here, choreographic sequences are usually thought and repeated simultaneously, with very short breaks in between them. Similarly, Jazz also includes short breaks between sequences, besides a variety of jumps and leaps.

On point of that, values of HR and VO_2 during dance classes and/or rehearsals demonstrated that peaks of moderate to vigorous exercise intensities can be achieved[28,31,32,36–38] in selected dance routines. For instance, Highland dance rehearsals attained HR values corresponding to moderate to vigorous aerobic intensity, while dance classes were performed most of the time at low aerobic intensity.[31] Particularly during a ballet lesson, center-floor routines (e.g. *temps levés* and *tours piqué*) attained higher VO_2 peaks than *barre* exercises. [36,37] In addition, when dance class intensity was assessed by METs, it reached moderate levels (under VO_2 [51] and questionnaire data analysis).[44] This shows that selected dance routines can active higher levels of intensity, and that the structure of the classes can be manipulated in order to maintain longer periods of time at MVPA. We suggest monitoring exercise-to-rest ratios of dance routines already learned and performed with satisfactory style and technique. An exercise-to-effort ratio of 1:1, with a dance routine lasting from 3−6 min, is recommended to induce cardiorespiratory adaptations.[65] Mixing different dance styles is also a strategy for fitness gains. For example, the use of elements from High Kick (HR 176 bpm),[31] Highland (151 bpm)[31] and Swing dance (143 bpm),[32] might be potential in inducing MVPA levels during a dance session.

Following that, our findings suggest that the limited time spent at MVPA during dance classes, affects the increases in daily/weekly MVPA as a result of regular dance practice. Indeed, most of the studies did not show any difference in the amount of daily/weekly MVPA of children and adolescents, comparing before and after dance interventions. [20,48,54,56,57] Length of the interventions, week frequency and duration of the sessions seem not to interfere in these results. Interventions varied from 5 wks [48] to 2 yrs, [56] performed from 1x/wk [49] to 5x/wk, [50] with dance sessions during from 30 min[49] to 75 min.[20] Only two studies showed significant increases in MVPA/weekly. [49,50] However, one of the studies combined dance with other type of exercises[50]; and the other one mentioned improvements only in vigorous PA(but did not present any data to support the changes).[49]

Regarding cardiorespiratory fitness and lipid profile adaptations from dance interventions, there was only one study reporting improvements on cardiorespiratory fitness,[57] and two studies evaluating the effects of dance interventions on lipid profile. [25,56] We highlight the reductions of ~6 mg/dL in LDL-C of overweight children, between 9 and 11 yers old, after a culture tailored dance intervention.[56] This is of relevance, considering that more than 70% of the children who present cardiovascular risk factors during childhood, are susceptible for developing obesity, dyslipidemia, atherosclerosis and T2DM, all chronic conditions associated with early mortality rates.[66] Conversely, each 1% decrease in LDL-C is estimated to reduce by 1% the incidence of coronary heart disease in 12-yrs time. [66] These very few results of improvements in cardiorespiratory fitness and lipid profile after dance interventions, may be related to increases in general levels of PA, quite expected after engaging in any regular type of PA . Indeed, increases in general levels of PA explain improvements in inflammatory, glycemic and lipid profile in different populations. [6] Increases in total energy expenditure and its relationship with reductions in adipose tissue generally explain that. [6] In this sense, greater length of the interventions (≥12 wks)[25,56,57] and exercise frequency (≥3x/wk) [25,56,57] may make a difference for cardiorespiratory fitness and metabolic improvements. However, the lack of sufficient data on this secondary outcomes limits this analysis.

Putting all together, we suggest that efforts to reach 50% of the time of a dance class at MVPA, practiced at regular bases, may be a potential strategy to contribute with increases in daily/weekly levels of MVPA. In this way, dancing may provide sufficient stimuli to improve health-related fitness and metabolic adaptations in children and adolescents. Great rates of adherence to dance interventions at long term, also support dance as a preventive strategy against the development of many diseases associated with physical inactivity throughout the life span, such as obesity and T2DM. [21] What is more, greater amounts of PA and enhanced cardiometabolic health have been related with improvements in sleep quality[13] and quality of life, [67] as well as reductions in the chance of developing obesity [68,69] and associated cardiovascular risk factors [7,8] early in life.

With respect to methodological quality, few studies presented low risk of bias. [20,56] The main weakness of the studies were the lack of reporting of adverse events, sample size calculation, randomization attempt to blinding and power analysis. In addition, when blind attempt was reported, studies did not identify if the blinding was referring to the randomization process or to the outcome evaluator. There was also no attempts to blind study subjects to the intervention, which contributes for greater risk of bias; however, this is quite expected considering the nature of study designs using dance interventions. On the other hand, we found proper description of participants, protocols of testing and information on drop outs and losses. Also, most of the studies presented a treatment representative of reality, performed at dance studios or school environments.

Large heterogeneity of the studies (different experimental designs, dance styles, methods of assessment and description of dance interventions) limit some conclusions on our primary and secondary outcomes. There is also a number of other outcomes which should be analysed to strength the evidence on the area of dancing, physical activity and health of the youth. For instance, body fat changes and rates of obesity before and after dance interventions; psychosocial correlates (*e.g* mood and quality of life); inflammatory profile and associated cardiovascular risk, among others. These topics were not approached in this review, but should be considered for future research. The parts of the world from where the studies came from, also impact the types of dance included in this review. They certainly do not contemplate the wide variety of traditional dances practiced worldwide (e.g Hula dance, Greek, Bhangra, etc). Moreover, few studies had the same experimental design and outcomes analyzed, impeding the performance of a meta-analysis. Additionally, different cut-off points for the classification of MVPA, made comparisons among studies more difficult. Thus, the lack of effect measures to support conclusions about the data described is a limitation of this review.

Nonetheless, at or our knowledge, this is the first systematic review analyzing the impact of dancing on the level of MVPA, cardiorespiratory fitness and metabolic responses of children and adolescents. This review maps the existing literature in terms of volume, nature, and characteristics of the primary research in this field. From that, some gaps in the

Table 4
Risk of bias assessment of individual studies, according to the Downs and Black instrument (1998).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	Total score	%	Bias
	Reporting										External Validity			Internal Validity (bias)							Internal Validity- confounding (selection bias)						Power			
Alhassan, et al., (2018)	1	1	1	1	0	1	1	0	0	1	0	0	1	0	0	1	0	1	1	1	1	1	1	1	0	0	2	18	56	Mod
Aujla, I. J., et al. (2015)	1	1	1	1	0	1	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	1	0	15	47	High
Baillie, Y., et al. (2007)	1	1	1	1	0	1	1	0	1	1	0	0	1	0	0	1	1	1	1	0	0	1	0	0	0	0	0	14	44	High
Baldari, C. (2001)	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	1	0	16	50	Mod
Burkart, S. et al. (2017)	1	1	1	1	0	1	1	0	0	0	0	0	1	0	0	1	1	0	1	1	1	0	1	0	0	1	0	14	44	High
Cain, K. L. et al. (2015)	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	0	0	0	1	1	0	17	53	Mod
Clarkson, P. M. et al. (1985)	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	1	1	0	1	1	1	0	0	0	0	1	0	15	47	High
Craig, S. S. et al.(2010)	1	1	1	0	0	1	1	0	1	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	1	0	13	41	High
Da Rosa, et al., (2018)	1	1	1	0	0	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	0	0	0	0	1	0	15	47	High
Flores, R. (1995).	1	1	1	1	0	1	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	0	0	10	31	High
Froberg, A., et al. (2017)	1	1	1	1	2	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	0	0	0	1	1	0	19	59	Mod
Gallotta, M. C. et al. (2011)	1	1	1	1	0	1	1	0	0	1	0	1	1	0	0	1	0	1	1	1	1	0	0	0	1	0	4	19	59	Mod
Gao, Z., et al. (2013)	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	16	50	Mod
Guidetti, L. et al.(2007)	1	1	1	1	2	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	15	47	High
Guidetti, L. et al. (2008)	1	1	1	1	2	1	1	0	0	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	3	17	53	Mod
Guidetti, L. et al. (2007)	1	1	1	1	2	1	1	0	1	0	0	1	0	0	0	1	1	1	1	1	0	0	0	0	0	1	3	19	59	Mod
Harrell, J. S. et al. (2003)	1	1	1	1	0	1	1	0	1	1	0	0	0	0	0	1	1	1	1	1	1	0	0	0	1	1	0	16	50	Mod
Hogg, J. et al. (2012)	1	1	1	1	1	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	1	1	0	19	59	Mod
Huang, S. Y. et al. (2012)	1	1	1	1	0	1	1	0	1	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	1	1	0	17	53	Mod
Jago, R. et al. (2015)	1	1	1	1	2	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	4	29	91	Light
Kulinna, et al., (2018)	1	1	1	1	0	1	1	0	1	1	0	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	0	21	66	Mod
Laurson, K. R. et al. (2008)	1	1	1	1	0	1	1	0	1	1	0	0	1	0	0	1	0	1	1	1	1	0	0	0	1	1	0	16	50	Mod
Lopez M. A., et al. (2015)	1	1	1	1	1	1	1	0	1	1	0	0	1	0	0	1	1	1	0	1	1	1	0	0	1	1	0	18	56	Mod
Matthews, B. L. et al. (2006)	1	1	1	1	0	1	1	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	0	0	1	0	0	12	38	High
Nelson, L. et al. (2011)	1	1	1	1	0	1	1	0	1	1	0	0	1	0	0	1	0	1	1	1	1	0	0	0	1	1	0	16	50	Mod
O'Neill, J. R., et al. (2011)	1	1	1	1	2	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	0	19	59	Mod
O'Neill, J. R., et al. (2012)	1	1	1	1	2	1	1	0	1	0	0	0	1	0	0	1	0	1	1	1	1	0	0	0	0	1	0	16	50	Mod
Olvera, N. et al. (2009)	1	1	0	1	0	1	1	0	1	1	0	0	1	0	0	1	0	1	0	1	1	0	0	0	0	1	0	13	41	High
Olvera, N. et al. (2010)	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0	1	1	1	0	1	1	1	0	0	0	1	0	15	47	High
Opstoel, K. et al. (2015)	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	16	50	Mod
Pekkarinen, H., et al. (1989)	0	1	1	1	1	1	1	0	1	1	0	0	0	0	0	1	1	0	1	1	1	1	0	0	1	1	0	16	50	Mod
Rice., et al. (2018)	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	1	0	1	1	1	1	0	0	0	0	0	0	14	44	High
Robinson, T. N. et al. (2010)	1	1	1	1	2	1	1	0	1	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	4	27	84	Light
Romero, A. J. (2012).	1	1	1	1	2	1	1	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	1	0	17	53	Mod
Schroeder, K. et al. (2017)	1	1	0	0	0	1	1	0	0	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	0	0	0	13	41	High
ThompsoN, W. M. et al. (2012)	0	1	1	1	2	1	1	0	1	1	0	0	1	0	0	1	1	1	1	1	1	1	0	0	1	1	0	19	59	Mod
Trost, S. G., et al. (2016)	1	1	1	1	2	1	1	0	0	0	0	0	1	0	0	1	1	1	1	1	0	1	0	0	1	1	0	17	53	Mod

literature were detected, which should be considered for further investigation, as follows: 1) the use of direct physiological markers of exercise intensity (VO_2 and HR) to classify MVPA, as well as METs classification, as proposed by Ridley et al. (2008).[70] Proper instruments of analysis (heart rate monitors and gas analyzers) should be also used; 2) a lack of control groups for comparisons, and better methodological quality of primary studies; 3) studies evaluating fitness health-related parameters at long term (*e.g* cardiorespiratory fitness, muscle strength and power, body composition, lipid, glycaemic and inflammatory profile); 4) Studies evaluating specific dance styles, from different parts of the world; and 5) Poor description of dance classes structure. Type of dance steps used, beats per minute of the songs, the length of dance routines and its exercise-to-rest ratios, are important variables to be described and considered in order to increase the time at MVPA during dance classes.

As future perspectives, we firstly purpose a video analysis of dance classes, aiming to identify factors that could contribute to large amounts of time at MVPA during dance classes. Following that, we suggest to evaluate VO_2 and HR responses of dance steps from different dance styles. This would be the base for a dance class structure that aims to spent at least 50% of the total time at MVPA.

Finally, findings of this review should be explored into two different contexts: i) the young dancers' curriculum: in the view that working on physiological and neuromuscular foundation, simultaneously to technical skills acquirement, may prevent from chronic and acute injuries. Indeed, high incidence of injuries are commonly reported with the increase in volume and intensity of classes and rehearsals over the course of the dancers' carriers[31,64,71]; ii) recreational young dancers: participants with and without overweight, obesity or other metabolic disturbances, who would benefit from dancing as a way of increasing levels of PA, and preventing from chronic diseases related with sedentary behavior.

5. Conclusions

This systematic review showed that during dance classes, children and adolescents did not meet 50% of the total class time at MVPA, which is recommended by health organizations. Following that, results from before and after interventions, indicated that dancing dos not contribute significantly to increases in daily/weekly MVPA. On the other hand, direct markers of exercise intensity (VO_2 and HR) attained peaks of moderate to vigorous exercise intensity during dance classes. This suggests that the structure of the dance classes may be manipulated to maintain longer periods of time at MVPA levels. Eventually, this should contribute with increases in daily/weekly levels of MVPA, providing sufficient stimuli to improve health-related fitness and metabolic adaptations in children and adolescents.

Authors contributions

G.C.S conceived the study idea, designed the work, analyzed and interpreted data, drafted all the manuscript and approved the final version. J.N.Q analyzed and interpreted data and approved the final version, A.R-O revised the manuscript and approved the final version. J. R-K designed the work, analyzed and interpreted data, revised the manuscript and approved the final version.

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Declaration of Competing Interest

The authors have no conflict of interest.

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