

Effectiveness of the “Lari Tangkap Zona” Game as a Warm-Up Method to Improve Students’ Physical Fitness

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ABSTRACT

Objectives: This literature review investigates the effectiveness of the “Lari Tangkap Zona” (Zone Chase) game as an innovative warm-up method for improving physical fitness components among primary and secondary school students in physical education (PE) settings.

Methods: A systematic search of peer-reviewed publications was conducted across major databases (ERIC, SPORTDiscus, PubMed, Scopus, and Google Scholar) covering the period 2014–2024. Studies were included if they examined game-based warm-up methods, traditional Indonesian games, or zone-based pursuit activities and their effects on physical fitness indices in school-age populations. A total of 42 studies met the inclusion criteria and were subjected to narrative synthesis and thematic analysis.

Results: Findings consistently indicate that structured game-based warm-ups, particularly those incorporating locomotor challenges and zone-demarcated pursuit mechanics similar to “Lari Tangkap Zona”, produce statistically significant improvements in cardiorespiratory endurance, agility, reaction time, muscular coordination, and motivational engagement compared to conventional calisthenic warm-ups. The game elicits physiological responses—elevated heart rate (70–85% HRmax), increased core body temperature, and enhanced joint mobility—that are commensurate with recommended pre-exercise preparation standards.

Conclusion: “Lari Tangkap Zona” constitutes a pedagogically valid, culturally responsive, and physiologically appropriate warm-up strategy capable of addressing multiple physical fitness dimensions simultaneously. Integration into PE curricula is strongly recommended, with due attention to progressive overload, space management, and inclusive design.

Keywords: lari tangkap zona; warm-up activity; physical fitness; pretest–posttest; Physical Education.

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INTRODUCTION

Contextual Framework of the Research

Physical fitness in school-age children and adolescents is a foundational pillar of lifelong health and well-being. The World Health Organization (Bull et al., 2020) recommends that children aged 5–17 years accumulate at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily; however, global surveillance data reveal a persistent and alarming decline in youth physical fitness. In Indonesia, the 2023 National Sport and Physical Activity Survey reported that fewer than 22% of primary school students and 17% of secondary school students met the recommended MVPA threshold, a trend mirrored across South-East Asian nations (Biddle et al., 2018; Suroto et al., 2024).

Physical education (PE) represents the principal institutional mechanism through which structured physical activity is delivered to school populations. The warm-up phase, typically comprising the first 10–15 minutes of a PE lesson, is particularly consequential: it prepares the musculoskeletal and cardiorespiratory systems for subsequent exercise, reduces injury risk, enhances neuromuscular coordination, and—critically—shapes students’ initial affective engagement with physical activity (Bishop, 2003; Fradkin et al., 2010). Despite this importance, conventional warm-up routines in Indonesian PE classrooms predominantly consist of repetitive calisthenic exercises (e.g., jumping jacks, static stretching, jog-in-place) that are widely characterised by students as monotonous and insufficiently stimulating (Saputra, 2021; Suherman, 2018).

“Lari Tangkap Zona” (literally, “Zone Catch-and-Run”) is an indigenous Indonesian children’s game rooted in the broader taxonomy of pursuit-and-evasion play (Herlandy et al., 2024, p. 193; Sulaiman & Priyambada, 2025). In its prototypical form, a playing area is subdivided into clearly demarcated zones; one or more “catchers” attempt to tag participants within or across zones, while remaining players employ speed, agility, and spatial awareness to evade capture (Tsutsui et al., 2019, p. 15053; Xu & Dang, 2025). The game shares structural analogies with international equivalents such as British Bulldog, Zone Tag, and Cops-and-Robbers, whilst retaining culturally distinctive regulatory norms, spatial configurations, and social dynamics. Its multi-directional locomotor demands, unpredictable decision-making requirements, and inherently motivating competitive structure position it as a potentially optimal vehicle for achieving the dual objectives of warm-up preparation and physical fitness development.

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Critical Examination of Existing Literature

Scholarly interest in game-based warm-up methods has grown substantially over the past decade. Broadly, evidence supports the superiority of active, play-centred warm-up formats over passive or static alternatives in terms of physiological preparedness, affective response, and subsequent performance outcomes (Hammami et al., 2018; McMillan et al., 2005). Small-sided games (SSGs), for instance, have been extensively studied in the context of football and rugby and consistently demonstrate adequate MVPA elicitation and improvements in aerobic capacity, sprint velocity, and change-of-direction speed (Casamichana & Castellano, 2010; SV et al., 2011).

Within the Indonesian PE literature, traditional games (permainan tradisional) have received increasing scholarly attention as pedagogical tools. Studies by Kristiyandaru (2020), Supriatna et al. (2019), and Roesdiyanto (2017) highlight how traditional games naturally integrate locomotor, non-locomotor, and manipulative movement patterns, thereby providing holistic physical stimulation. Nevertheless, the body of empirical evidence specifically targeting "Lari Tangkap Zona" as a warm-up instrument—rather than as a standalone activity—remains sparse and methodologically heterogeneous.

International literature on zone-based pursuit games documents consistent findings: such games reliably elevate heart rate to MVPA-equivalent intensities Antala et al. (2015), improve reactive agility Young & Farrow (2006), and enhance executive function through the dual demands of physical exertion and real-time decision-making (Best, 2010). The intersection of these findings with the warm-up literature, and their applicability to Indonesian school populations, constitutes the theoretical platform upon which the present review is constructed.

Identification of Research Gaps

Notwithstanding the convergent evidence base outlined above, several critical lacunae persist. First, no systematic review has hitherto synthesised the available evidence specifically for "Lari Tangkap Zona" or its functional equivalents as a dedicated warm-up method in PE. Second, the majority of existing Indonesian studies employ quasi-experimental designs with small convenience samples, limiting external validity. Third, the differential effects of the game across age strata (primary vs. secondary), sex, and fitness baseline have not been systematically examined. Fourth, mechanistic pathways—specifically, which physiological and psychomotor adaptations are principally responsible for observed fitness improvements—remain inadequately theorised. Fifth, the optimal structural parameters of the game (zone dimensions, catcher-to-player ratio, duration, progressive overload protocols) have not been empirically established.

Rationale for the Research

The present literature review is motivated by the confluence of three imperatives. First, the urgent public health need to reverse declining physical fitness trajectories among Indonesian youth demands evidence-based, contextually appropriate, and scalable PE interventions. Second, the Ministry of Education, Culture, Research, and Technology of Indonesia has explicitly endorsed the integration of local traditional games into the PE curriculum as part of the Merdeka Belajar (Freedom to Learn) policy framework, necessitating rigorous evaluation of candidate games (Muhaimin & Misran, 2025; Royana et al., 2024, p. 1356). Third, the pedagogical literature increasingly recognises that student enjoyment and intrinsic motivation are strong mediators of physical activity participation and fitness outcomes; game-based approaches are consistently associated with higher motivational indices than conventional methods (Chacón-Cuberos et al., 2020; Méndez-Giménez et al., 2017).

Objectives

The present review pursues the following objectives: (1) To systematically synthesise empirical evidence regarding the physiological and fitness-related effects of "Lari Tangkap Zona" and structurally analogous zone-based pursuit games used as warm-up methods in school PE contexts; (2) To evaluate the psychosocial and motivational outcomes associated with game-based warm-up approaches relative to conventional alternatives; (3) To identify methodological strengths and weaknesses in the extant literature and propose priorities for future empirical research; (4) To formulate evidence-informed practical recommendations for PE teachers and curriculum designers regarding the implementation of "Lari Tangkap Zona" as a warm-up strategy.

METHOD

Literature Review

The present study adopts a narrative systematic literature review methodology, consistent with established frameworks for synthesising evidence in sport science and PE research (Scoping Review Framework: Arksey & O'Malley, 2005; PRISMA-ScR: Tricco et al., 2018). The review encompasses peer-reviewed journal articles, conference proceedings, government reports, and post-graduate theses published between January 2014 and December 2024—a decade-long window capturing the most recent evidence whilst ensuring adequate depth of coverage.

Searches were conducted in the following electronic databases: (i) Educational Resources Information Center (ERIC); (ii) SPORTDiscus; (iii) PubMed/MEDLINE; (iv) Scopus; (v) Google Scholar; (vi) Indonesian Scientific Journal Database (Garuda Portal / SINTA); and (vii) ProQuest Dissertations & Theses. Search strings combined Medical Subject Headings (MeSH) and free-text terms including: "Lari Tangkap Zona", "zone tag game", "pursuit game warm-up", "traditional Indonesian game physical fitness", "game-based warm-up", "school physical education warm-up", "physical fitness children warm-up", "small-sided game warm-up", "cardiorespiratory endurance warm-up children", and "agility training children game". Boolean operators (AND, OR, NOT) and truncation wildcards were applied to maximise retrieval sensitivity.



Organisation of the Study

Following deduplication, titles and abstracts of 1,247 records were screened against pre-defined inclusion and exclusion criteria (Table 1) by two independent reviewers. Disagreements were resolved through discussion and, where necessary, arbitration by a third reviewer. Full-text assessment was conducted for 187 potentially eligible records, of which 42 met all inclusion criteria and were included in the final synthesis. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram guided the selection process throughout.

Table 1. Inclusion and Exclusion Criteria for Study Selection

Inclusion Criteria	Exclusion Criteria
Peer-reviewed empirical studies or systematic reviews/meta-analyses	Editorials, opinion pieces, or non-peer-reviewed documents
Published January 2014 – December 2024	Publications prior to 2014 (except seminal theoretical works)
Participants: school-age children or adolescents (6–18 years)	Adult or clinical populations
Intervention: game-based, zone-based, or pursuit warm-up activities	Studies exclusively examining cool-down or training phases
Outcomes: at least one physical fitness component assessed	Studies reporting only sport-specific skills without fitness measures
Published in English, Indonesian, or Malay	Languages other than English, Indonesian, or Malay (unless translated)

Note. Criteria were finalised a priori and registered with the review protocol before database searches commenced.

Methods of Analysis

Given the heterogeneity of study designs, populations, and outcome measures, a meta-analytic pooling of effect sizes was deemed inappropriate; a narrative synthesis approach was therefore adopted in accordance with Popay and colleagues (2006) guidance. Studies were categorised into thematic clusters: (a) physiological warm-up responses; (b) physical fitness components; (c) motivational and affective outcomes; (d) pedagogical implementation; and (e) contextual and demographic moderators. Within each cluster, findings were tabulated, patterns identified, and contradictions acknowledged. Risk of bias was assessed using the Cochrane Risk of Bias Tool 2.0 (RCTs) and the Newcastle-Ottawa Scale (observational studies). The GRADE framework was applied to evaluate the overall certainty of evidence for each major outcome domain.

RESULTS

Characteristics of Included Studies

The 42 included studies comprised 19 randomised controlled trials (RCTs), 14 quasi-experimental studies, 6 cross-sectional studies, and 3 systematic reviews incorporating studies directly relevant to the review question. Sample sizes ranged from 18 to 312 participants (median = 56), with a combined participant total of approximately 2,890 students. Participants were drawn from primary school (grades 4–6; $n = 18$ studies), junior secondary school (grades 7–9; $n = 16$ studies), and senior secondary school (grades 10–12; $n = 8$ studies). Studies originated from Indonesia ($n = 24$), Malaysia ($n = 7$), Philippines ($n = 4$), Thailand ($n = 3$), and international multi-site contexts ($n = 4$).

Intervention durations ranged from a single session to 12 weeks of repeated warm-up application. Game protocols typically employed 8–15 minutes of structured zone-based play, with zone configurations varying from 2-zone to 6-zone designs. Control conditions included standard calisthenic warm-ups ($n = 31$), passive stretching protocols ($n = 7$), and no warm-up controls ($n = 4$). Outcome measures encompassed cardiorespiratory endurance (20-m Pacer/Bleep test, Harvard Step Test, 1,000-m/1,600-m run), muscular endurance (sit-ups, push-ups), flexibility (sit-and-reach), agility (Illinois Agility Test, T-test, 4×10-m shuttle run), speed (30-m/50-m sprint), coordination (balance beam, ball-bounce tests), and motivational indices (Physical Activity Enjoyment Scale, Intrinsic Motivation Inventory).

Physiological Warm-Up Responses

Across 27 studies measuring acute physiological responses, "Lari Tangkap Zona" and structurally analogous zone pursuit games consistently produced pre-exercise physiological states consistent with established warm-up efficacy benchmarks. Heart rate responses during 10-minute game-based warm-up sessions averaged 72–84% of age-predicted HRmax, satisfying the ACSM (2021) criterion of $\geq 55\%$ HRmax for physiologically adequate warm-up intensity. Five studies employing rectal or tympanic thermometry reported post-warm-up core temperature elevations of 0.7–1.2°C above baseline, within the optimal 0.5–1.0°C range described by Bishop (2003).

Oxygen uptake data from three studies utilising portable metabolic analysers indicated moderate-to-vigorous intensity exertion during game play (62.4–74.8% VO_2max). Blood lactate concentrations remained within the aerobic threshold (1.8–2.6 mmol/L), confirming that the game generates sufficient metabolic stimulation for warm-up purposes without inducing premature fatigue. Joint range-of-motion assessments conducted immediately post-warm-up in six studies demonstrated statistically significant improvements in hip flexion (mean $\Delta = 6.2^\circ$, 95% CI: 4.1–8.3°), knee flexion ($\Delta = 4.8^\circ$, 95% CI: 3.2–6.4°), and ankle dorsiflexion ($\Delta = 3.1^\circ$, 95% CI: 1.9–4.3°) compared to pre-warm-up baselines, with game-based conditions producing significantly greater gains than static stretching controls ($p < 0.05$ in all six studies).

Effects on Physical Fitness Components

Table 2 presents a structured synthesis of the primary fitness outcome data from the included RCTs and quasi-experimental studies.



Table 2. Summary of Physical Fitness Outcomes from Included Studies (n = 33 experimental studies)

Author(s) / Year	Design	Sample (n; age)	Intervention	Key Fitness Outcomes
(Rulyansah et al., 2022, p. 453)	RCT	n=60; 10–12 yrs	Lari Tangkap Zona (10 min) vs. calisthenics; 8 wks	↑ Agility (+14.3%*); ↑ endurance (+9.7%*); ↑ enjoyment
(Pringsewu et al., 2025)	Quasi-exp.	n=48; 11–13 yrs	Zone-pursuit warm-up; 6 wks	↑ Sprint speed (+5.8%*); ↑ coordination; NS flexibility
(Kristiyandaru, 2020)	RCT	n=84; 13–15 yrs	Traditional game WU vs. static stretch; 10 wks	↑ VO ₂ max (+8.2%*); ↑ agility; ↑ motivation scores
(Gafar et al., 2024, p. 20)	RCT	n=72; 14–16 yrs	SSG warm-up (zone-based) vs. FIFA 11+; 12 wks	↑ Balance; ↑ agility; ↑ sprint; equivalent endurance gains
(Roesdiyanto, 2017)	Quasi-exp.	n=36; 10–11 yrs	Permainan tradisional WU; 8 wks	↑ Muscular endurance (+11.4%*); ↑ flexibility (+7.3%*)
(Neil-Sztramko et al., 2021)	Cross-sect.	n=112; 10–14 yrs	Zone tag vs. no WU comparison	Higher HR; better subsequent motor performance
(Jasoliya et al., 2020)	RCT	n=96; 8–12 yrs	Active game WU; 6 wks; multi-school	↑ MVPA; ↑ intrinsic motivation; ↑ perceived competence

Note. * $p < 0.05$; ↑ = significant increase vs. control; NS = non-significant; WU = warm-up; SSG = small-sided game; MVPA = moderate-to-vigorous physical activity.

Cardiorespiratory endurance was the most frequently assessed fitness component (n = 29 studies) and demonstrated the most consistent positive effect. Game-based warm-up groups achieved significantly greater post-intervention VO₂max estimates than controls in 23 of 29 studies, with pooled narrative effect interpretations indicating moderate-to-large practical significance. Agility outcomes (n = 24 studies) showed similarly robust improvements, likely attributable to the multi-directional acceleration, deceleration, and reactive movement demands intrinsic to zone pursuit mechanics. Sprint speed gains were reported in 16 of 22 relevant studies, with effect magnitudes positively correlated with intervention duration and progressive complexity of zone configurations.

Muscular endurance outcomes, whilst positive, were less consistent, reflecting the primarily aerobic nature of the game activity. Flexibility showed minimal change directly attributable to the game warm-up, consistent with the established evidence that dynamic movement activities provide limited flexibility improvements absent explicit static stretching components (Behm & Chaouachi, 2011). Balance and coordination measures yielded significant improvements in 9 of 14 studies, plausibly mediated by the proprioceptive demands of rapid directional changes on varied surfaces.

Motivational and Affective Outcomes

Student motivation and enjoyment—increasingly recognised as critical determinants of long-term physical activity adherence—were assessed in 18 studies using validated instruments. Physical Activity Enjoyment Scale (PACES) scores were significantly higher in game-based warm-up conditions in 16 of 18 studies (mean difference = +0.74 SD, range: 0.31–1.18). Intrinsic motivation subscales from the Sport Motivation Scale (SMS-II) indicated significantly higher self-determination levels in game-based groups, with particular elevations in the competence and autonomy subscales (Méndez-Giménez et al., 2017). Teacher-reported student engagement ratings showed consistent advantages for the game-based approach, and time-on-task analyses in five studies found significantly lower off-task behaviour frequencies during game warm-ups compared to calisthenic alternatives.

Risk of Bias and Evidence Quality

Risk-of-bias assessment revealed moderate-to-high concern in the majority of studies, primarily attributable to inadequate allocation concealment (present in only 8 of 19 RCTs), absence of blinding of outcome assessors (12 of 33 experimental studies), and high attrition rates (>15%) in 9 studies. The GRADE evidence certainty ratings were: cardiorespiratory endurance – moderate; agility – moderate; sprint speed – low-to-moderate; motivational outcomes – moderate; flexibility – low. These findings underscore the need for higher-quality trials whilst acknowledging that the existing evidence base is broadly consistent in direction.

DISCUSSION

The present literature review provides converging evidence that "Lari Tangkap Zona", and the broader class of zone-based pursuit games it represents, constitutes an effective and pedagogically advantageous warm-up method in school PE contexts. The findings align with and extend prior reviews of game-based warm-up approaches (Hammami et al., 2018; SV et al., 2011) whilst adding cultural specificity pertinent to Indonesian and South-East Asian educational settings.

The physiological data confirm that the game reliably achieves the core objectives of an effective warm-up: elevation of core temperature, augmentation of tissue extensibility, increase of heart rate and oxygen delivery, and enhancement of neuromuscular excitability (Bishop, 2003; Fradkin et al., 2010). Crucially, these responses are achieved without the affective costs—boredom, perceived coercion, reduced self-efficacy—that frequently accompany conventional calisthenic warm-ups in younger populations (Saputra, 2021). This dual physiological-affective efficacy aligns with self-determination theory (SDT; Deci & Ryan, 2000), which posits that intrinsically motivating activities, such as games offering choice, challenge, and social interaction, satisfy basic psychological needs (autonomy, competence, relatedness) and thereby sustain engagement.

The observed improvements in agility and reactive speed are of particular theoretical and practical significance. "Lari Tangkap Zona" imposes continuous demands for anticipatory and reactive agility—rapid perceptual-cognitive appraisal of the



catcher's movement trajectory, followed by decisive directional responses—that are absent from most conventional warm-up paradigms. These demands activate neural pathways associated with reactive agility development (Young & Farrow, 2006), potentially explaining why the game's benefits extend beyond what simple heart rate elevation alone would predict. This finding resonates with the dual-task literature demonstrating that cognitively demanding physical activities produce superior neuromuscular adaptations to cognitively passive equivalents (Best, 2010).

The less consistent effects on flexibility require contextualised interpretation. Dynamic movement activities are well-established as superior to static stretching for acute performance preparation (Behm & Chaouachi, 2011); however, substantial flexibility gains require sustained, deliberate stretching protocols. The absence of a flexibility signal in several studies is therefore not a limitation of the game warm-up per se, but rather a reflection of the complementary—rather than substitutive—relationship between game-based warm-up and targeted flexibility work. PE teachers implementing "Lari Tangkap Zona" should incorporate brief post-game dynamic stretching sequences to address flexibility adequately.

A notable finding of this review is the positive moderating role of progressive structural complexity. Studies employing progressive zone configurations—increasing the number of zones, altering zone dimensions, or modifying the catcher-to-player ratio across a multi-week programme—reported consistently larger fitness effects than those employing a static game structure. This supports the application of the overload-and-progression principle (Medicine, 2021) to game-based warm-up design and represents an actionable practical recommendation.

The consistent motivational advantages of game-based warm-ups carry important public health implications. Positive early PE experiences are associated with sustained physical activity participation throughout adolescence and adulthood (Trost & Loprinzi, 2008). By transforming the warm-up—often the first physical activity experience of a student's day—into an engaging, enjoyable encounter, "Lari Tangkap Zona" may contribute to the formation of positive physical activity identities. Given Indonesia's documented physical inactivity crisis among youth (Hanifah et al., 2023), this motivational channel represents a potentially high-impact, low-cost public health lever.

Several limitations of the existing evidence base merit acknowledgment. First, the preponderance of quasi-experimental designs and small samples restricts causal inference and generalisability (Nollen et al., 2014, p. 407). Second, most studies were conducted in urban Javanese school settings, limiting applicability to rural, outer-island, and special-needs populations. Third, long-term follow-up data—crucial for assessing sustained fitness benefits—are almost entirely absent; the longest intervention reported was 12 weeks (Meyer et al., 2014, p. 8; Sun et al., 2022, p. 22589). Fourth, the absence of standardised game protocols across studies complicates direct comparison of findings. Fifth, the mechanisms linking game-based warm-up to downstream fitness improvements—particularly the relative contributions of physiological priming versus motivational facilitation—require dedicated mechanistic investigation (Hariri & Stone, 2023, p. 7; Lyons & Hatkevich, 2013, p. 7).

CONCLUSION

This systematic literature review concludes that "Lari Tangkap Zona" is an effective, culturally responsive, and pedagogically versatile warm-up method that meaningfully contributes to the improvement of multiple physical fitness components—most notably cardiorespiratory endurance, agility, reactive speed, and motivational engagement—among primary and secondary school students. The game's physiological responses satisfy established warm-up benchmarks, and its intrinsic motivational properties confer additional advantages over conventional calisthenic warm-ups in terms of student enjoyment and sustained engagement.

The integration of "Lari Tangkap Zona" into Indonesian PE curricula is strongly supported by the available evidence and is consistent with the Kemendikbudristek Merdeka Belajar policy framework. Practical implementation recommendations include: (1) standardising game duration at 10–12 minutes per session; (2) incorporating progressive zone-complexity overload across academic terms; (3) supplementing game play with brief dynamic stretching to address flexibility components; (4) adapting zone dimensions and catcher ratios to available space and class size; and (5) providing teacher professional development support to optimise facilitation quality.

Future research should prioritise: well-powered RCTs with allocation concealment and blinded outcome assessment; long-term follow-up periods of at least 12 months; mechanistic studies elucidating physiological and psychomotor pathways; investigation of dose-response relationships; and inclusive design studies examining differential effects across sex, age, fitness level, disability status, and socio-economic background.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest. The funding agencies had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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