



Narrative review of the influence of high-intensity interval training on adolescents' bone health: commentary and perspectives

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Abstract: Although several benefits have been associated to high-intensity interval training (HIIT), there is a lack of clarity on the HIIT effects in adolescents, especially on bone health outcomes. To address this gap, our research aimed to perform a systematic review, which focus on the influence of HIIT on adolescents' bone health. Our search strategy was conducted on three databases (PubMed, SCOPUS, and Embase). For our review, we included articles with the following characteristics: (I) sample consisting of adolescents (10–19 years old), (II) HIIT interventions; and (III) assessment of bone health outcomes. Longitudinal and clinical trials studies with no language and year of publications restrictions were eligible to be included. A total of 63 eligible studies were identified. After removing the duplicates and screening the titles and abstracts, six articles remained to be read in full text. However, none of the articles met our criteria. Studies in which no article meets the eligibility criteria are also essential and need to be shared with the academic community because it may stimulate appropriate future investigations in this field. This lack in the review results highlights the need for further epidemiological research focusing on this topic, including high quality, large scale, and longitudinal studies, as well as randomized controlled trials to confirm or refute efficacy.

Keywords: Schoolchild; teenager; bone mineral content; bone mineral density (BMD); high-intensity interval training (HIIT)

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Introduction

The development of bone mineral density (BMD) and content (BMC) during childhood and adolescence is substantial and may attenuate the incidence and effects

of osteoporosis later in life (1). Recent study assessed 663 Danish students over 6 years from childhood to adolescence and found positive associations between the level of physical activity and bone health (2). Systematic reviews have shown that physical activity, as well as weight-

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bearing exercises, enhance bone mineral accrual (3-6). According to current recommendations on physical activity for children and young people, vigorous-intensity activities are essential, “including those that strengthen muscle and bone, at least 3 times per week” (7). Both moderate and vigorous activities are indicated to reach wide health benefits, including bone health (8,9), but the greatest benefit is provided by vigorous intensity physical activity (10-13), which is associated with the healthiest outcomes and the lowest risk of developing diseases later in life (11,14,15).

Nowadays, high-intensity interval training (HIIT) is in the spotlight from both scientific and practical views. By definition, HIIT involves alternating short bursts of high intensity exercise with recovery periods or light exercise (16) and requires ‘near maximal’ efforts ($\geq 80\%$, maximal heart rate; or $\geq 80\%$, maximal oxygen consumption) (17). Recent meta-review (18) analyzed 33 systematic reviews (child to adult) and found evidences suggesting that HIIT may improve anthropometric variables, exercise capacity, cardiorespiratory fitness, cardiovascular function, and anxiety and depression severity in both healthy individuals, as well as those with physical health disorders. Despite these health evidences support HIIT practice, only 5 reviews (19-23) from all 33 addressed children and adolescents, which reflects that the focus has been given to adult population.

Although several benefits have been associated to HIIT (18), to the best of our knowledge, there is a lack of clarity on the HIIT effects in adolescents, especially on bone health outcomes. So, here we aimed to perform a systematic review, which focus on the influence of HIIT on adolescents’ bone health. We present the following article in accordance with the Narrative Review reporting checklist (available at <http://dx.doi.org/10.21037/tp-20-166>).

Methods

For the review, we included articles with the following characteristics: (I) sample consisting of adolescents (10–19 years old, as defined by the World Health Organization), (II) HIIT interventions; and (III) assessment of bone health outcomes (such as BMC or BMD). Longitudinal and clinical trials studies with no language and year of publications restrictions were eligible to be included. Studies with (I) incomplete data, (II) review articles, and (III) specific populations including athletes, hospitalized adolescents, diseased and disabled people were excluded.

Our search strategy was conducted on three databases

(PubMed, SCOPUS, and Embase). As the pattern, the following combinations of three sets of keywords were used in the Pubmed:

(“adolescent”[MeSH Terms] OR “minors”[MeSH Terms] OR “adolescent”[Title/Abstract] OR “minors”[Title/Abstract] OR “Youth”[Title/Abstract] OR “juvenile”[Title/Abstract] OR “teen”[Title/Abstract] OR “teenager”[Title/Abstract] OR “Childhood”[Title/Abstract] OR “adolescence”[Title/Abstract] OR “schoolchild”[Title/Abstract] OR “Schoolchildren”[Title/Abstract] OR “young”[Title/Abstract])

AND

“bone density” [MeSH Terms] OR “bone health” [Title/Abstract] OR “bone density” [Title/Abstract] OR “bone densities” [Title/Abstract] OR “bone mineral density” [Title/Abstract] OR “bone mineral densities” [Title/Abstract] OR “bone mineral content” [Title/Abstract] OR “bone mineral contents” [Title/Abstract] OR “bone tissue” [Title/Abstract] OR “bone and bones” [MeSH Terms] OR skeleton [MeSH Terms] OR skeleton [Title/Abstract] OR “bone mass” [Title/Abstract] OR “bone demineralization” [Title/Abstract] OR “bone development” [Title/Abstract] OR “densitometry” [MeSH Terms] OR “densitometry” [Title/Abstract] OR “bone architecture” OR “bone structure” OR “bone strength”

AND

(“High-intensity training”[Title/Abstract] OR “High-intensity interval training”[Title/Abstract] OR “high-intensity interval training”[MeSH Terms] OR “high intensity intermittent training”[Title/Abstract] OR “Repeated sprint training”[Title/Abstract] OR “interval training”[Title/Abstract] OR “intermittent training”[Title/Abstract] OR “high intensity sprint”[Title/Abstract] OR “aerobic interval training”[Title/Abstract] OR “High-intensity interval training”[Title/Abstract] OR “high-intensity interval exercise”[Title/Abstract] OR “high-intensity interval exercise”[Title/Abstract] OR “high-intensity intermittent exercise”[Title/Abstract] OR “high-intensity intermittent exercise”[Title/Abstract] OR “high intensity intermittent training”[Title/Abstract] OR “high intensity intermittent training”[Title/Abstract] OR “HIIE”[Title/Abstract] OR “HIIT”[Title/Abstract]).

The same keywords groups have been used in the Scopus and Embase. The search was performed on 05 September 2020 by two independent researchers (MN and CRM), which also checked all the references in order to search for other potential articles. Then, the two reviewers (MN and CRM) independently screened the titles and abstracts of

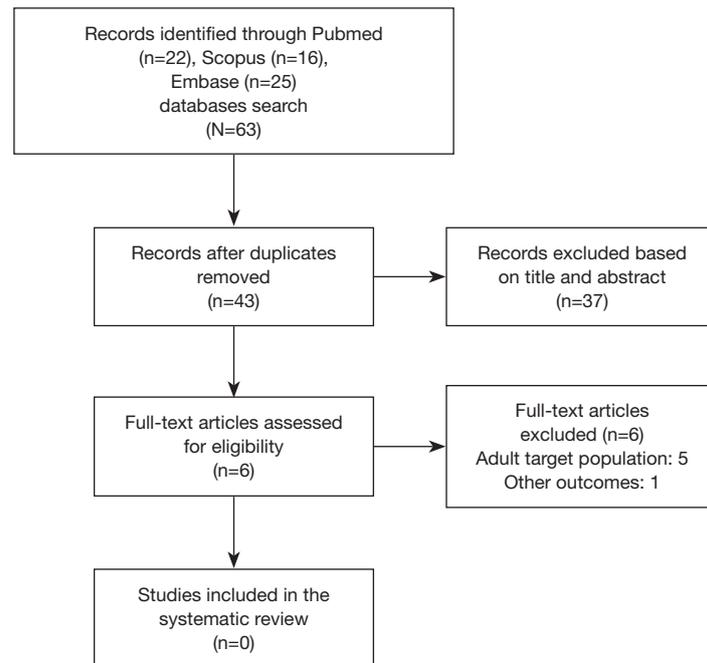


Figure 1 PRISMA flow diagram of the selection criteria for the study.

all articles identified in the literature search for inclusion. Disagreements regarding inclusion of articles were resolved by a third reviewer (PN).

Results

A total of 63 eligible studies were identified (PubMed, 22 studies; Scopus, 16 studies; Embase, 25 studies). After removing the duplicates and screening the titles and abstracts, six articles remained to be read in full text (*Figure 1*). However, none of the articles achieved our criteria as all six studies were excluded because they were performed with adults.

Discussion

This lack of evidences on the influence of HIIT on adolescents' bone health emphasize the need for further observational studies, as well as randomized clinical trials to evaluate the effectiveness of HIIT on bone health. In this regard, we believe to be relevant sharing our findings in this Narrative Review, because this presented knowledge gap may motivate further studies in this thematic and help to develop this research line. According to Yaffe *et al.* (24), reviews in which no study meets the eligibility criteria are also essential and need to be shared with the academic

community because it may stimulate appropriate future investigations in this field.

Given that (I) current recommendations suggest that vigorous intensity physical activity (10-13) for young people achieve large health benefits and reduce the risk of developing diseases later in life (11,14,15), including bone health (8,9), (II) HIIT may improve health-related outcomes (19,21-23,25,26), and (III) the development of bone health during childhood and adolescence is substantial and may be an important protective factor for osteoporosis and fractures (1), it becomes essential to understand HIIT effects on bone health in adolescents, specially nowadays when this type of exercise is on spotlight. Briefly, recent studies with adults showed that HIIT can be an effective way to improve BMC and BMD (27), and regular power-based training and competition in sprinting and jumping is associated with better maintenance of bone mass (28).

As previous evidences have suggested (18), HIIT may also improve anthropometric variables, cardiorespiratory and cardiovascular functions, and mental health. Studies mainly with adults have shown a good adherence rate of $\geq 80\%$ and HIIT appears to be safe, with no acute injuries or serious cardiovascular events, similar to other active controls (18). Despite this positive evidences, HIIT adherence and adverse events should be carefully addressed

in adolescent populations, for both sexes as well as different puberty stages. Further recommendations as type of movement, exercise duration and frequency, and rest intervals remain unclear due to the lack of studies currently available (23).

So, it is essential to understand more in-depth the HIIT effects on adolescents' bone health because it may provide a pragmatic complement to the Physical Education lessons (25) and underpin the formulation of national guidelines. Moreover, it may provide essential information for public health programs, as well as contribute to developing more specific and effective sports training programs, mainly directed to the school environment.

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Footnote

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at <http://dx.doi.org/10.21037/tp-20-166>

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

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