Economics and Human Biology 10 (2012) 299–309

Contents lists available at SciVerse ScienceDirect

Economics and Human Biology

journal homepage: http://www.elsevier.com/locate/ehb

Review

Dairy products and physical stature: A systematic review and meta-analysis of controlled trials

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ARTICLE INFO

Article history:
Received 4 May 2010
Received in revised form 9 August 2011
Accepted 9 August 2011
Available online 17 August 2011

Keywords:
Growth
Body height
Physical stature
Milk
Dairy products
Nutrition
Controlled trials
Systematic review
Meta-analysis
History
Biological standard of living

ABSTRACT

The positive relationship between per capita availability of dairy products and average height found in historical studies (for instance in nineteenth century Bavaria, Prussia and France; Baten, 2009) does not necessarily indicate a causal relationship. Historical studies usually apply non-experimental methods that may produce substantial bias. Modern experimental controlled studies may provide high quality evidence supporting a causal relationship between consumption of dairy products and physical growth. This paper provides a systematic review and meta-analysis of controlled trials investigating the effect of supplementing usual diet with dairy products on physical growth. Twelve studies provided sufficient, independent data for meta-analysis. Seven studies were conducted since the 1990s. The other studies were conducted between 1926 and 1980. Studies were conducted in Europe, USA, China, Northern Vietnam, Kenya, Indonesia and India. Many studies had some internal validity problems such as lack of randomisation or dissimilarity of groups at baseline regarding height and age, which affects the quality of evidence.

Meta-analysis and sensitivity analysis showed that the most likely effect of dairy products supplementation is 0.4 cm per annum additional growth per ca 245 ml of milk daily. Meta-regression analysis indicated that milk might have more effect on growth than other dairy products while lower height-for-age and being a teenager increased the effect of supplementation.

In conclusion, there is moderate quality evidence that dairy products supplementation stimulate linear growth supporting hypotheses that changing levels of consumption of dairy products in the 19th and 20th centuries contributed to trends in height.

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doi:10.1016/j.ehb.2011.08.003

1. Introduction

Dairy products play an important role in explaining historical trends or regional differences in height. One example is the so-called antebellum puzzle in early-nineteenth century United States of America (Komlos, 1987; Komlos et al., 1992; Zehetmayer, 2011). An other example is the study of regional height differences in nineteenth century Bavaria, Prussia and France (Baten, 2009). Perhaps milk consumption also played a role in more recent height trends. Dutch boys for instance who were born in the late seventies of the 20th century are 5.6 cm taller than their peers born in the USA, whereas Dutch soldiers born about 1900 were 2 cm smaller than native-born American recruits.[1]

According to the economic historians Komlos and Baten proteins are responsible for the growth stimulating effect of dairy products. However, to date it is not clear which components in milk could be responsible for a possible growth-stimulating effect. According to Hoppe et al. (2006, pp. 153–155) "potential candidates are bioactive peptides, amino acids, cow's milk IGF-I (hdb: insulin-like growth factor), or milk minerals, including calcium". These bioactive peptides can be found in both casein and whey. The amino acids leucine, isoleucine, and valine may have a particular stimulating effect on insulin secretion.[2] Also calcium or zinc could play a role in stimulating growth since both minerals have impact on proportions and density of bones.

Associations between the intake of dairy products and linear growth found in historical research are usually based on non-experimental methods. Such associations might not be causal relationships for it cannot be excluded that other (unknown) factors associated with the intake of dairy products independently influence linear growth. Especially ecological studies, studies at group or population level, are prone to bias (the so-called ecological fallacy) because relationships observed for groups do not necessarily hold for individuals. Only in experimental studies, especially in randomised controlled trials, there is the possibility to control for unknown factors. By randomly allocating persons to an intervention and a control group, groups are comparable as regards known and unknown factors that might influence the outcome of an intervention.

Hoppe et al. (2006, p. 146) reviewed the literature on cow's milk and linear growth and concluded that "overall, published results on the association between cow's milk intake and height strongly suggest that the intake of cow's milk has a stimulating effect on linear growth, although not all studies showed an effect. ...It appears that cow's milk may have the strongest effects in children with existing undernutrition ...". The review of Hoppe et al. (2006) was not systematic in that the authors did not conduct a systematic literature search and did not assess the validity of study findings or the methodological quality of the included studies. So, there are reasons for conducting a systematic review. Our review question is: do dairy products supplementation trials in children or adolescents consistently show extra linear growth compared to the growth effect of usual diet?[3]

2. Methods

2.1. Criteria for considering studies for this review

Both randomised and non-randomised controlled trials on children and adolescents (aged 2–18 years) were included in this review. Trials also studying very low birth weight infants, subjects with a history of diseases that negatively influenced physical growth, and overweight or obese subjects were excluded. To be included trials should evaluate the effect of supplementation of usual diet with dairy products on linear growth. Only trials reporting height, change in body height, height percentiles or height *z*-scores were included.

2.2. Search methods for identification of studies

PubMed was searched for relevant studies with the following keywords: dairy products AND (growth OR body height). The search was limited to both randomised and non-randomised clinical trials.[4] Apart from trials also narrative reviews were sought in PubMed as a source of useful references. Relevant articles on controlled trials found in PubMed were also screened for useful references.[5] Moreover, epidemiologic studies that reported trial data were sought in PubMed.[6]

[1] Heights can be found in Komlos and Breitfelder (2007); Drukker and Tassenaar (1997); Steckel (2002) and Zehetmayer (2011).

[2] Perhaps cow's milk IGF-I stimulates growth although it is questionable whether this will be bioactive given proteolysis in the gut. IGF-I is a growth factor in bone, and mediates the effects of pituitary growth hormone.

[3] According to Liberati et al. (2009, p. W66) a systematic review has the following key characteristics: "(a) a clearly stated set of objectives with an explicit, reproducible methodology; (b) a systematic search that attempts to identify all studies that would meet the eligibility criteria; (c) an assessment of the validity of the findings of the included studies, for example through the assessment of risk of bias; and (d) systematic presentation, and synthesis, of the characteristics and findings of the included studies".

[4] PubMed's search engine translated these keywords as follows: ("dairy products" [MeSH Terms] OR ("dairy" [All Fields] AND "products" [All Fields]) OR "dairy products" [All Fields]) AND (("growth and development" [Subheading] OR ("growth" [All Fields] AND "development" [All Fields]) OR "growth and development" [All Fields] OR "growth" [All Fields] OR "growth" [MeSH Terms]) OR ("body height" [MeSH Terms] OR ("body" [All Fields] AND "height" [All Fields]) OR "body height" [All Fields])) AND ("humans" [MeSH Terms] AND Clinical Trial [ptyp] AND English [lang] AND ("child, preschool" [MeSH Terms] OR "child" [MeSH Terms:noexp] OR "adolescent" [MeSH Terms])). The search was limited to ages from 2 to 18 year.

[5] References in referenced articles were not screened for relevance.

[6] The following key words were used: (dairy products) AND (growth OR body height) AND epidemiologic studies [Mesh]. The search was limited to ages from 2 to 18 year. PubMed's search engine translated these keywords as follows: "epidemiologic studies"[MeSH Terms] AND (("body height"[MeSH Terms] OR ("body"[All Fields] AND "height"[All Fields]) OR "body height"[All Fields]) OR ("growth and development"[Subheading]. OR ("growth"[All Fields] AND "development"[All Fields]) OR "growth and development"[All Fields] OR "growth"[All Fields] OR "growth"[MeSH Terms])) AND ("dairy products"[MeSH Terms] OR ("dairy"[All Fields] AND "products"[All Fields]) OR "dairy products"[All Fields]) AND ("humans"[MeSH Terms] AND ("child, preschool"[MeSH Terms] OR "child"[MeSH Terms:noexp] OR "adolescent"[MeSH Terms])).