

Childhood obesity and curcumin: a possible effective anti-obesity adjunct

Abstract

Obesity, a largely intractable health condition with incalculable health, financial and social costs and ramifications and often emerging in the context of early childhood and without amelioration thereafter, remains an immense challenge to mitigate effectively, despite years of study. Consequently, interventions that can limit the early onset of obesity, or help to reduce this to any degree where present, remain of high significance. Studied now for over 20 years, the role of spices such as turmeric that contains a yellow pigment known as curcumin, a derivative employed widely in Asian dietary and health contexts for centuries appears promising for purposes of combating obesity and its analogues such as diabetes. Based on available data, this mini review specifically discusses some findings regarding curcumin and obesity, and what has been observed to date. Extracted from current literature, it is concluded that this is a field of significant promise, but one requiring more research among young people as well as diverse obesity associated conditions across time.

Keywords: childhood obesity, curcumin, intervention, obesity, systematic review, treatment

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Background

A large volume of research published over the last two to three decades continues to reveal that the health status of the American nation as well as global health status is generally declining, especially in the realm of persistently high rates of adult and childhood obesity,¹⁻³ despite years of research and multiple clinical and public health endeavors. A health condition often associated with the emergence or persistence of multiple chronic health conditions, such as metabolic syndrome, as well as psychological health correlates, a state of obesity has now also been shown to prevail among young people, rather than only adolescents and middle aged and older adults, and is harder to reverse, the earlier the onset.

Deemed to be a preventable condition in many cases, and present as a result of an energy imbalance consequent to the interaction of suboptimal human health practices and behaviors, rather than genetic factors, a multitude of calorie restrictive diets, lifestyle and physical activity recommendations, have been put forth for purposes of averting excess weight gain at all ages and predominate over most other anti-obesity approaches. These approaches have not however been shown to produce any sizeable and meaningful population-wide impact for more than 20 years, nor any clear cut agreement on the best nutritional approach.⁴ As well, synthetic anti-obesity drugs that have been developed continue to show side effects and variable effectiveness.³ Promising however, is the more recent emergent evidence that shows obesity is not solely a disease where excess fat prevails, but is one associated with a variety of inflammatory manifestations and others that may be amenable to amelioration through the use of various naturally occurring compounds, and specifically various spices or combinations thereof.⁵

Indeed, a diverse set of recently published study results that have emerged speak to a targeted role for polyphenols, a class of natural bioactive phytochemicals, including curcumin, the active yellow colored ingredient located in the spice called turmeric that has a long history of medicinal use,⁶ as having the potential to mitigate obesity and its adverse impact on adipose tissue.¹ Moreover, even though not all current authors agree, it does appear curcumin, an important compound present in the *Curcuma longa* L. rhizome is a lipophilic

molecule that can rapidly permeate cell membranes to exert its effect. Other intervention studies that have examined the impact of dietary polyphenols including curcumin have further shown its ability to improve insulin resistance, as well as obesity-associated low grade inflammatory responses, a main determinant of the pathology of multiple chronic health conditions, and possibly caused in part by an inadequate nutrient intake that induces alterations in the lipid content of adipose tissue and activation of immune and adipose cells and others that foster local and systemic inflammation.⁷

Additional recent evidence points not only to the anti-inflammatory effects of curcumin in this regard, but also its metabolic effects that can help to relieve obesity, as well as obesity-associated chronic health conditions.⁷ Moreover, curcumin appears to have pharmacological properties that objectively lower body weight, fat mass and triglyceride levels, while enhancing energy expenditure, fat utilization, and glucose hemostasis.² Unsurprisingly, among the many beneficial health affirming impacts reported for curcumin, research specifically focused on obesity and the metabolic-preventing/suppressing aspects of curcumin is growing.⁸ This review specifically elected to examine and summarize if and how curcumin a common component of many diets and herbal remedies in Asia can contribute to the reduction of excess weight and suffering in overweight cases, especially among those who are in their formative years, but also among those who might already have a variety of comorbid health conditions.

Indeed, any approach that can minimize the onset and/or the progression and maintenance of excess body weight from the earliest point in time is increasingly paramount according to Hosseini et al.,⁹ Calcaterra et al.,¹⁰ and Garcia et al.¹¹ This is because obesity is not only a serious health condition in its own right, but is one strongly associated with the onset or exacerbation of: cardiovascular events, type 2 diabetes, chronic pain and inflammation, asthma, sleep disturbances, gall bladder disease, COVID-19 disease, possible micronutrient deficiencies, adverse antioxidant status, and some types of cancer, even among young adults, and possibly school children. A major increasing cause of multiple forms of disability and reduced life quality, obesity is hence a public health concern of major proportion in most countries in 2022 and one where no effort should remain unexplored in seeking a cost effective and life affirming solution.¹⁰

In particular, recent compelling evidence that obesity is related to an imbalance in oxidative stress processes,⁹ has led to the idea that perhaps antioxidant-based treatments may yet prove useful in the search for mechanisms that can possibly prevent or counteract obesity fat accumulation and its complications as demonstrated in an animal model of artificially induced obesity by Lee et al.¹² It is also possible, that even though attempts have been made to modify diets directly, the ability to add antioxidants such as curcumin to various foods or offer this as a supplement may prove helpful in advancing desirable protective efforts to both offset, as well as intervene upon obesity and overweight in general, if its bioavailability is not undermined.¹³ Mechanisms that appear operative in this respect are multiple and are attributed in part to the ability of curcumin to alleviate intracellular oxidative stresses, reduce chronic low-grade inflammation, inhibit adipogenesis and lipogenesis, and suppress the differentiation of pre adipocytes to mature adipocytes.¹

This aforementioned and proposed idea, while quite novel and not supported by all,¹⁴ does appear worthy of exploration though in our view. The topical emergent literature is thus duly the focus of this brief scoping narrative review, and was designed to garner access to key observations, especially those that might pertain to youth, and identify gaps in the literature and recommendations for future research and practice. As discussed by Alappat et al.¹⁵ obesity, defined as the accumulation of excessive fat may interfere with the maintenance of an optimal health state, while heightening the risk for cardiovascular diseases and others, and is a growing problem that needs to be considered more thoroughly and through different lenses than is currently evidenced. In particular, the benefits of curcumin, a multifaceted component of the root known as turmeric, may help counter oxidative stress, while preventing or alleviating inflammation, among other obesity correlates and could possibly be readily applied in the form of a functional food.^{12,15,16}

Objective

This brief was designed to examine the evidence for considering curcumin as one approach that could be helpful in the context of efforts to prevent or reduce obesity among children, and what is known about why this realm of endeavor holds promise.

Methods

To achieve the aims of this review, PUBMED, PubMed Central, and GOOGLE SCHOLAR believed to house salient topical peer reviewed articles on the current realm of interest were specifically sought using the key terms Anti-Obesity Effects, Childhood Obesity, Obesity, and Curcumin. No limitations were placed on document type or year of publication and while some articles may have been overlooked, an effort to select most of the salient published articles in these data bases was made. After an extensive search, all pertinent data were carefully scanned and if relevant embedded in this mini review. This work is not a systematic one however, but a scoping review summarizing key study findings. Readers who wish to learn more can benefit from the paper by Alsharif et al.,⁴ Mousavi et al.¹⁷ Simental-Mendía et al.¹⁸ and Jafarirad et al.¹⁹ where many details on curcumin obesity associations are systematically provided on this topic. Excluded were general articles dealing with curcumin in health spheres other than obesity and its correlates, and the majority of molecular related and animal model studies.

Results

Studied since 2005, a fair number of articles prevail that discuss curcumin and obesity, in general, but only a very few discuss

curcumin relative to childhood obesity specifically as of December 2022, even though many later life obesity manifestations clearly emerge in early life and are hard to mitigate once manifest, and most preclinical research stems from observations of acutely or artificially induced obesity, rather than long term obesity states. Moreover, while promising research points to curcumin having a possible demonstrable anti-obesity impact wherein mechanisms of action can be discerned, not all researchers agree that curcumin has any clinically superior impact in efforts to offset obesity among various samples suffering from excess weight that have been studied. As well, most data stem from cellular or preclinical studies in animal models of obesity that may not represent the human condition at all accurately. As well, very few well construed and controlled human studies yet prevail, regardless of age category. At the same time, unlike many realms of clinical research where interventions yield positive effects, but the mechanisms underlying this are unknown, many current lab studies are able to provide a strong rationale for why curcumin would be expected to prove efficacious in anti-obesity efforts.

According to a synthesis by Aggarwal et al.⁵ curcumin may be effective in addressing obesity reduction efforts because it is shown to reduce body fat and weight gain,^{20,21} as well having the ability to directly interact with fat cells termed adipocytes, among others. It also appears to suppress several proinflammatory transcription factors, and can activate diverse cell-signaling pathways that induce the downregulation of multiple adipokines, plus the upregulation of adiponectin and other gene products. Similarly Wang et al.² report that curcumin can reduce the viability of adipocytes including the proliferation of preadipocytes, while suppressing adipocyte differentiation and triglyceride accumulation. Wang et al.² affirm curcumin appears to help stimulate lipolysis, fatty acid β -oxidation, and multiple anti-oxidant and anti-inflammatory responses that are associated with obesity states. Preclinical data further show curcumin to have a pronounced effect on obesity as demonstrated by its impact on lowering body weight, fat mass and triglycerides, and in averting weight gain, while enhancing energy expenditure, fat utilization, and modulating glucose hemostasis, as well as metabolic syndrome and reducing lipid levels in white adipose tissue in obese rats.^{22,23} These curcumin-induced alterations are consequently found to reverse insulin resistance, hyperglycemia, hyperlipidemia, and other symptoms linked to obesity states,⁵ including excess weight gain and adiposity.²⁴

Bradford et al.²⁵ reports that curcumin does appear impactful because it can be seen to directly interact with white adipose tissue to suppress chronic inflammation, and within adipose tissue, curcumin can inhibit macrophage infiltration and nuclear factor κ B (NF- κ B) activation induced by inflammatory agents. At the same time, curcumin does appear to reduce the specific expression of several potent pro-inflammatory adipokines, while inducing the expression of adiponectin, the principal anti-inflammatory agent secreted by adipocytes, as well as having anti-oxidant properties that can help reduce inflammation.²⁶ Thus, as put forth by Alappat et al.¹⁵ curcumin, the active ingredient in the spice known as turmeric, may be helpful in efforts to regulate lipid metabolism, which plays a central role in the development of obesity and its complications. Indeed, through its multiple and diverse mechanisms of action, curcumin, a natural compound, may not only reduce obesity, but may help to curtail the adverse health effects of obesity as shown by Wu et al.²⁷ as well as Chen et al.²⁸

Unsurprisingly Mokgalaboni et al.²⁹ who recently carried out a systematic review concluded that even though more research is warranted, it does appear curcumin supplementation has the potential

to significantly reduce blood glucose and triglycerides levels, including markers of liver function. In addition, its observed effects are consistent with those associated oxidative stress and inflammatory marker declines that have been noted, and that otherwise tend to predominate among persons considered obese, as well as among those obese cases who exhibit one or more accompanying chronic health conditions.

Other related research has shown curcumin supplementation along with use of a weight loss diet might have beneficial effects on some cardiovascular risk factors among overweight and obese female adolescents.³⁰ Importantly, the application of curcumin in various forms has been deemed safe and tolerable as well as effective in the context of chronic disease management in more than 100 clinical trials.³¹

Shehzad et al.³² has concluded that after an extensive review of the literature, emergent data tend to affirm the modulation of several cellular transduction pathways implicated in obesity that can be positively mitigated in the presence of curcumin. Furthermore, not only are the molecular pathways sufficiently identifiable to rule out a placebo impact alone, but the relatively low cost of curcumin, plus its safety record and proven efficacy in multiple health spheres make it advisable to include curcumin as part of healthy diet. Bianconi et al.³³ recently concluded that according to the existing literature, curcumin may regulate lipid metabolism, and suppress chronic inflammation and its interactions with white adipose tissue, which plays a central role in the complications associated with obesity, wherein curcumin appears to consistently inhibit the differentiation of adipocytes, while improving their anti-oxidant properties, a highly probable key to preventing and effectively mitigating against chronic diseases,³⁴ and obesity.²² Generally supportive of this view is additional current research by Islam et al.³⁵ showing curcumin does appear to exert protective metabolic effects in dietary obesity states, in part through the downregulation of adipose tissue inflammation, and metabolism of curcumin into curcumin-O-glucuronide, along with other mechanisms.

Hassan et al.³⁶ who conducted a recent mechanistic study concluded curcumin does have the ability to exert potent antitoxic, anti-oxidant, tissue-protective, and anti-obesity effects, hence they recommended curcumin be added to various dietary regimens to prevent or delay organ dysfunction among obese people. Tsuda et al.³⁷ similarly agree that curcumin has anti-obesity/anti-adipogenic and anti-diabetes biological properties among others, as also observed by Labban et al.³⁸ and can be seen to have a high probability of preventing or reducing the magnitude of various obesity states through well defined biochemical signaling pathways and others that may be active even on preadipocytes,³⁹ as well as in reversing or modulating age and obesity associated metabolic diseases.^{16,40}

Most noteworthy is that it has also been shown that curcumin is a bioactive compound that may not only have multiple beneficial health and anti-oxidative effects,⁴¹ but a beneficial effect on the course of SARS-CoV-2 infection and that might hence be helpful in the prevention of long-COVID complications-and others that are closely associated with cardiovascular diseases and obese states.^{42,43} Dietary curcumin supplementation may also promote health in general,⁴ while helping promote white adipose tissue browning found in obese states. Curcumin supplementation may also impact energy expenditure,⁴⁴ and serve as an adjunct to mitigating non alcoholic fatty liver disease,⁴⁵ inflammation and oxidative stress markers among postpubescent overweight and obese girl adolescents,⁴⁶ plus anti-arthritis, anti-diabetic, excess lipid and depressive health issues that often impact

obesity.⁴ It may also have a role to play in lowering the risk of developing cardiovascular diseases in overweight and obese pediatric subjects.⁴⁷ while improving biomarkers of oxidative stress and inflammation in conditions of obesity, and type 2 diabetes,²⁹ and non-alcoholic fatty liver disease, visceral fat, and abdominal obesity.^{48,49} Safari et al.⁵⁰ concur that available studies do tend to indicate that curcumin has beneficial impacts on various anthropometric indices, such as body weight and BMI,^{17,51} even if disputed by some [eg., 19]. Other analyses imply a significant increase in plasma levels of adiponectin following curcuminoids therapy, which may be one of the mechanisms of anti-inflammatory activity of curcumin.¹⁸

As discussed by Xu et al.⁵² and Jin et al.⁵³ curcumin a polyphenol found in turmeric has consistently been reported to have anti-oxidant, anti-inflammatory, hepatoprotective, anti-atherosclerotic, and anti-diabetic properties, among others, that may be highly effective in countering the onset and progression of excess body mass in youth and across the lifespan. Sarkur et al.⁵⁴ moreover, claim independent of their effects on adiposity; dietary curcumin and caloric restriction have positive effects on frontal cortical functions that could be linked to anti-inflammatory or antioxidant actions. Also noteworthy is that curcumin has been shown to have a protective effect against weight regain and impaired metabolic control following a successful period of weight loss through diet and exercise, perhaps via inhibition of glucocorticoid action and inflammation. This is very noteworthy given strong evidence that weight regain after dieting and exercise is a common phenomenon plaguing many individuals.⁵⁵ Figure 1 illustrates how curcumin might prove impactful for many at risk or suffering from excess body weight or a predilection for body weight gain.

STATE OF OBESITY/RISK + CAREFULLY TAILORED CURCUMIN INTAKE

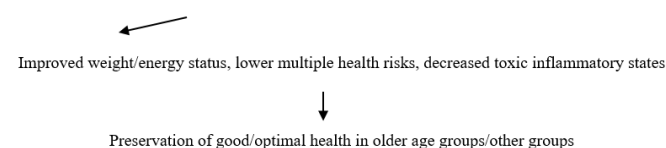


Figure 1 Schematic representation of possible benefits of curcumin supplementation in cases of intractable obesity or those at risk for obesity.^{4,33,35–37,40,42,56,57}

Summary and discussion

Obesity is not just a state of being overweight, but a highly impactful metabolic disorder associated with the accumulation of excess visceral fat and the release of high concentrations of free fatty acids into various organs. It represents a state of chronic oxidative stress and low-grade inflammation whose intermediary molecules may include leptin, adiponectin and cytokines, and that may progress to hyperglycemia, leading to type 2 diabetes, and possible obesity exacerbation,^{4,15} wherein even young children who are overweight are at an especially high risk for acquiring one or more of these serious health problems.

However, as based on recent research, it appears that in addition to diet and exercise approaches for intervening in the cycle of obesity, phytochemicals, such as curcumin which have anti-inflammatory properties and are being intensely investigated²⁵ have shown multiple beneficial effects in the realm of attenuating body weight gain, improving insulin sensitivity, and preventing diabetes development in rodent models, as well as in prediabetic subjects. Indeed, alone or in combination with exercise and other strategies, it does appear that curcumin in its various forms where present or administered in adequate amounts is likely to either help initiate or offset excess

weight, and promote weight loss, more often than not, and via well defined cellular pathways and molecular mechanisms of action, that support its apparent ameliorating effect on inflammation and diabetes extent, especially in cases with early onset obesity, or where losing weight via traditional interventions may be a perpetual ‘losing’ battle. As well, even though more research is needed in multiple spheres wherein its application in the wider context of weight loss and/or helping to avert excess weight gain should be differentiated in different age groups and health conditions, especially children, the importance of assessing whether those at risk for obesity have adequate intakes of curcumin must surely be relevant to consider in efforts to mitigate the severe impact on childhood as well as adulthood of obesity.

To this end, and mindful this brief report is not without limitations, it is yet argued that in light of the magnitude of a single situation of intractable obesity especially one involving a child or young person, and our pervasive inability to currently offer timely efficacious resolutions in this event, we would strongly encourage medical care providers plus health and nutrition educators to consider reviewing the evidence base in this regard, and especially the fact that many naturally occurring spices may have potent biological properties that can be safely and effectively harnessed to high advantage in multiple chronic disease spheres, including the context of obesity. Thereafter, if deemed clinically sound, efforts to encourage and support their thoughtful and possible more mainstream anti-obesity dietary usages where possible and depicted in Figure 1 are strongly suggested. At the same time, researchers are encouraged to pursue this possible line of inquiry so as to offer ascertain the potential of curcumin for specifically mitigating childhood obesity and its metabolic analogues, and if efficacious to perhaps examine how children might be encouraged to ingest safe amounts of curcumin if they are prone to excess weight, as they may not have a predisposition for seeking or wanting spicy type foods or food additives. As per Calcaterra et al.¹⁰ appropriate early dietary intervention for the management of pediatric overweight and obesity including optimal and informed parental feeding practices is strongly recommended for fostering overall healthy child growth and the prevention of emergent comorbidities in adulthood, and is likely to be preferable to pharmacologic approaches for many reasons even though nano technology is being employed to develop curcumin-based synthetic methods of delivery.¹⁰ To achieve some of the noteworthy obesity-associated effects observed to date,⁵⁶⁻⁵⁹ the most optimal level and desirable mode and duration of any curcumin supplementation, as well as its frequency of usage among different sub groups should however be studied more intently and carefully in well designed basic as well as clinical trials to arrive at any clear consensus and to discern why or how some authors dispute any role for an obesity reducing curcumin derived impact.⁶⁰

Concluding remarks

This current scoping review, while not all encompassing, clearly shows:

1. Obesity, a highly pervasive adverse health concern in all spheres of the globe and impacting all age categories and health status groups, is increasing in prevalence and lethality due to its impact on COVID-19 and multiple chronic physical and mental health associated conditions.
2. Efforts towards reducing this immensely costly largely irreversible health problem clearly warrant ongoing and immediate attention.
3. Among the potential mechanisms for offsetting some degree of obesity, and its ramifications, the role of the spice known as curcumin currently appears to exhibit very favorable promise based on its ability to interact at the cellular and molecular level, and attested to in most emergent cellular, preclinical and clinical data sets that could be adapted to support the idea of personalized and precision medicine.
4. In addition to helping young and older adults to limit their fat intake, a role for curcumin in helping to avert a life of possible immense suffering cannot be ruled out and deserves attention and supportive funding so as to provide more affirmative and generalizable data as well as for securing potentially far reaching specific insights that could lower childhood as well as adult obesity rates and associated social and personal costs, and possible excess death rates, for example due to COVID-19 susceptibility, and at low cost when compared to other available anti-obesity approaches.

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Conflicts of interest

The author declare no conflicts of interest.

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