Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
A community perspective of COVID-19 and obesity in children: Causes and consequences

Maido Tsenoli a, Jane Elizabeth Moverley Smith b, Moien AB Khan c,d,*

a Community Healthcare NHS Foundation Trust, Birmingham, B32 2TR, UK
b Bodreinallt Surgery, NHS Wales, Conwy, LL32 8AT, United Kingdom
c Department of Family Medicine, College of Medicine and Health Sciences, United Arab Emirates University, Al Ain, 15551, United Arab Emirates
d Primary Care, NHS North West London, London, TW3 3EB, UK

ARTICLE INFO

Keywords:
COVID-19
Childhood obesity
Pandemic
Primary care
Community interventions
Biopsychosocial model

ABSTRACT

The pandemic of childhood obesity that has been increasing over the last decade has collided with the current pandemic of COVID-19. Enforced behavioural changes have resulted in a myriad of problems for children particularly in weight management. Restricted activity is the most obvious but many other aspects of life have exacerbated biological, psychosocial, and behavioral factors identified as risks for childhood obesity. Significant effort is required to turn around the prevailing tide of weight gain necessitating changes in personal and family behavior and diet, as well as high-level governmental and educational policy. Evidence-based, focused, long-term interventions which are adequately funded are required. Enthusiasm and optimism for change coupled with public engagement by utilization of new technology as well as traditional methods offers hope for change. Public health interventions in isolation are inadequate and bolder changes to central policies and social structure are needed for sustained change. This will allow some mitigation of the effects of COVID-19 but also reduce negative outcomes in future comparable situations.

1. Introduction

Childhood obesity is a major and rapidly accelerating public health challenge (Wang and Lobstein, 2006). Recent governmental strategies to minimize the spread of COVID-19 through school closures, lockdowns, and alterations in social interaction have complicated childhood weight management efforts (Workman, 2020). Widespread disruption of normal educational and social routines has affected 75% of the world’s students (Di Pietro et al., 2020), and, as school closure is associated with weight gain (Rundle et al., 2020), and the precipitous nature of school closures has led to rapid increases in body mass for some children. Children with higher body mass index (BMI) have greater risk of poor outcomes from COVID-19 infections. This is in addition to having increased rates of morbidity and mortality from obesity-related chronic diseases (Eriksson et al., 2003; Zachariah et al., 2020). Other added burdens of childhood obesity are lower educational achievement and psychological distress (Rankin et al., 2016).

COVID-19 has put more strain and burden on the healthcare system (Al Falasi and Ab Khan, 2020). Health inequality has been apparent for years, but the present pandemic has highlighted its effects due to the catastrophic outcomes of many of the affected obese victims of COVID-19 (Martin-Howard and Kyle Farmbry, 2020). The biopsychosocial (BPS) model underpins the complex dynamic interactions between the biological, psychological, and social constructs causing obesity (Engel, 1978). In 2020, the world has witnessed perhaps a greater exacerbation of these biopsychosocial factors than ever before. Visualizing the effect of the pandemic from the perspective of the BPS framework allows identification of the causes and manifestations of weight gain in children. This approach will help identify strategies for weight management in children during pandemic conditions from a community perspective. We also appraise policies in this review to mitigate the factors leading to childhood weight gain in future situations.

https://doi.org/10.1016/j.obmed.2021.100327
Received 12 November 2020; Received in revised form 6 February 2021; Accepted 10 February 2021
Available online 15 February 2021
2451-8476/© 2021 Elsevier Ltd. All rights reserved.
2. Biological factors

2.1. Obesity and immune dysregulation; added risks of COVID-19 in obesity

The severity of many viral infections is positively correlated with obesity, and COVID-19 is no exception. Whilst children generally have mild symptoms from COVID-19 infections, those with obesity are at increased risk of serious disease. Adipose tissues is an active endocrine organ and excess causes a low grade inflammatory state (Finelli, 2020; Steene-Johannessen et al., 2010) with increased production of multiple proinflammatory adipokines such as leptin, TNF-α and IL-6 (Finelli, 2020). Inflammatory markers are raised and the pre-existing state of subclinical inflammation, heightened by daily stress, reduces immunity to viral illnesses such as COVID-19 (Khederi et al., 2020). Children infected with COVID-19 have an altered and overactive immune system with an increased production of inflammatory markers such as such as CRP, IL-6 or IL-1 (Finelli, 2020). Though children have milder symptoms from COVID-19 infections, due to a differential expression of cell surface enzyme angiotensin-converting enzyme 2 (ACE2) (Gabbert et al., 2010; Luzi and Radaelli, 2020). The risk of severe disease increases and a child with a raised BMI is more likely to be hospitalised with COVID-19 (Chao et al., 2020; Zachariah et al., 2020). Vulnerability is further heightened by low levels of physical activity imposed by lockdown which reduces pro-inflammatory cytokine inhibition and macrophage activation (Luzi and Radaelli, 2020). Obesity is more common in deprived socioeconomic communities and in ethnic populations and so the observation of higher mortality and morbidity in these groups can be explained partially through immune dysregulation secondary to excess adipose tissue (Iguacel et al., 2018).

Ethnic origin also has links to severe disease via Vitamin D levels. Vitamin D deficiency has been linked to worse COVID-19 outcomes (Grant et al., 2020). Vitamin D is postulated to have anti-inflammatory and anti-microbial properties, decreasing the production of inflammatory cytokines (Grant et al., 2020). Overweight children are therefore at risk from adipose tissue activity, biome changes and vitamin D deficiency.

A further immune dysfunction common to both obese children and COVID-19 patients is an altered gut biome with changes in Firmicutes/Bacteroidetes ratio (Indiani et al., 2018) and altered colonized Lactobacillus and Bifidobacterium bacterium. An increase in opportunistic gut pathogens and reduction in beneficial commensals is seen in COVID-19 patients and thought to be related to disease severity (Zuo et al., 2020).

3. Psychosocial factors and behavioural change

3.1. Family and school

COVID-19 has altered many aspects of family life that will impact on childhood weight gain. Determinants of weight are at work from birth, and factors such as maternal weight gain in pregnancy, parental smoking, infant feeding methods and parental obesity all contribute (Griffiths et al., 2010). COVID-19 lockdown may well have affected these influences.

Behavioural changes stemming from school closures will have weight-related consequences. School holidays have been shown to result in weight increases (Franckle et al., 2014) and this is more pronounced in those of ethnic backgrounds and those already overweight (Franckle et al., 2014; Hawkins et al., 2009). Rapid childhood weight gain is particularly significant as a predictor of adult obesity (Griffiths et al., 2010) and that experienced during school breaks is likely to be swift. Quick weight gain also predisposes children to obesity-related medical conditions, such as insulin resistance, type 2 diabetes, hypertension, and dyslipidemia in adolescence (Khan et al., 2019; Silva et al., 2020).

Reasons for this ‘holiday’ change in weight can be related to more time spent on eating, access to food, particularly unhealthy choices is easier, and eating larger food portions more frequently in the presence of others is observed (Díaz-Zavala et al., 2017). At the same time, those more deprived children experience food insecurity, having limited and unreliable access to healthy food at home. The lack of school meals can result in malnutrition (Van Lancker and Parolin, 2020) and obesity (Eisenmann et al., 2011). Country of origin, racial and ethnic differences are also implicated (Cecchin and Vuik, 2019; Inghley et al., 2016). These observations, seen in prearranged school holidays, are likely to be reflected in lockdown closures although, as these have been unplanned and prolonged, the outcomes are likely to be more significant.

3.2. Screen and media time

During lockdown, children tend to spend more time online and watching television (Nagata et al., 2020). Concerns exist regarding the influence of repreated exposure to aggressive advertising by food manufacturers on TV, the internet and through video games. The practice of promoting unhealthy food choices directly to children has recently intensified. (Castelló-Martínez and Tur-Vives, 2020; Khajeheian et al., 2018; Tadesky et al., 2020). Recognition of this trend, in 2020, led the UK government to place a ban on TV advertising before 9 p.m. of foods high in fat, sugar, and salt.

A focused family meal time is a recognized protective factor against obesity (Fiese et al., 2012) and this is being eroded with the observation that half of children’s meals are consumed in front of a screen (Khan et al., 2019; Matheson et al., 2004). Reduced recognition of the importance of meal times is associated with being overweight. Furthermore, dining in front of the television is associated with unhealthy foods and snacking (Trofholz et al., 2019).

3.3. Physical inactivity

Lockdown has had substantial effects of levels of childhood physical activity. The lockdown enacted in response to COVID-19 has altered lifestyle patterns, possibly exacerbating weight gain (Khan and Moverley Smith, 2020; Rundle et al., 2020). The forms of routine physical exercise that are ordinarily practiced by children, such as walking to and from school, have been lost (Margaritis et al., 2020), and the closure of parks and other leisure facilities has made exercise difficult. Outside activity is believed by some to increase the risk of infection; therefore, some children have been rendered housebound. Anxiety related to perceived risk, and low motivation are cited as reasons for reduced play activity (Hiatt et al., 2012). All age groups have been affected, including pre-school infants, for whom interaction with peer group friends is vital (Loades et al., 2020).

3.4. Psychological factors

COVID-19 has had significant effects on the mental health of both adults and children with 25% of adults and 14% of children reporting a deterioration (Patrick et al., 2020). Parental pressures have been intensified by the pandemic, namely employment and financial insecurity, home educating and relationship strain. There have also been more incidents of domestic abuse and family breakdowns. Stresses are transmitted to children, adding to their psychological burden which naturally has a negative impact on children’s wellbeing (Woo Baidal et al., 2020).

Reduced social interaction also causes feelings of isolation and loneliness, which can precipitate or worsen mental health disorders (Hiatt et al., 2012; Margaritis et al., 2020) and such psychological difficulties can lead to emotional eating in adolescents (Gouveia et al., 2019) which in turn is associated with obesity.

3.5. Health inequalities and poverty

Health inequalities seen in vulnerable populations and ethnic groups
have been highlighted during the pandemic (Townsend et al., 2020). Poverty, ethnicity, living conditions, density of population and underlying medical conditions have had both a direct and indirect impact on both COVID-19 infections and obesity (Townsend et al., 2020).

Food insecurity, discussed earlier, can cause long-term developmental, psychological, emotional, and physical distress, even when it is of a short duration (Balanza-Martínez et al., 2020; Branscum et al., 2010). Vulnerable groups tend to have lower educational attainment and limited access to technology and the internet. Van Lancker and Parolin (2020) gave food security as an example of a many recurring social problems that persists through generations when inequalities relating to education and social advancement are not addressed.

4. Perspectives and solutions

The impact of lockdown conditions on weight gain in vulnerable children needs acknowledgment and future planning is required to minimize resultant health problems and avoid future repetitions.

As the OECD reports, many countries have developed strategies to address obesity, but often these are limited to adults. Childhood obesity tends to be neglected, and few child-specific policies have been implemented. The high risk from severe COVID-19 infections among the obese population must intensify public health efforts to reduce childhood obesity. Addressing modifiable factors is of paramount importance and one of the most compelling is that of poverty. Other socio economical factors such as food insecurity, poor physical health and lower educational attainment, deprived communities need central policies to improve their outcomes.

Food insecurity and malnutrition emerging from a lack of food access during school closures requires direct governmental action. Provisions to bridge the gap such as the “Grab-n-Go” meal scheme in South Carolina, in which five days’ worth of food was given to those normally receiving free school meals, have proved popular (Dunn et al., 2020). This offers advantages over vouchers in that a balanced diet can be guaranteed. In the UK’s “Healthy Start” scheme successfully used targeted vouchers enable low-income families with children under the age of five to receive help with milk, fruit, and vegetable costs (McFadden et al., 2014). Highlighting healthy food choices and advocating physical activity via TV and multi-media interfaces is a beneficial means of promoting healthy behaviors among teenagers which has been utilized in the English campaign “change4life” (Fiese et al., 2012).

It is apparent from evidence regarding the influences behind weight change during lockdown that family relationships and functioning play a significant role (Skelton et al., 2020). Early intervention in family nutritional education such as promoting breastfeeding, weaning appropriately, regulating portion size for children, and encouraging healthy food choices, enhance self-regulation, which, as we have seen, is a key feature in maintaining a healthy weight. Improving parental skill in managing children’s feeding is essential (Cormack et al., 2020; Ordway et al., 2018). Hiatt et al. (2012) have identified challenges such as financial and time constraints as well as a failure of parental engagement. Parent-child relationship and the familial relationship to food and eating are influential in weight gain (Savage et al., 2007) so providing education regarding diet and the provision of healthy meals and avoiding the unrealistic assumption that children will choose healthy options over unhealthy ones will be rewarding (Tan and Holub, 2011). The emergence of virtual parenting groups allows parents and professionals to share child-rearing tips, including advice on healthy eating, physical activity, and behavior management.

Psychological stress and tension, which have been exacerbated during lockdown, can also be alleviated by the practice of mindfulness. Achieved in a variety of ways, mindfulness can be comforting and relaxing (Seabrook et al., 2020). Successful use of mindfulness involving children and their parents has reduced childhood weight gain. (Jastreboff et al., 2018). Seabrook et al. (2020) have used virtual reality technology effectively with positive outcomes (Seabrook et al., 2020).

Such methods of delivery may be extremely valuable in times of constrained activity, as they can allow a sense of escape from COVID-19 restrictions. Already proven to improve sleep and reduce overeating (Shomaker et al., 2019; de Carvalho et al., 2017), mindfulness has great potential and should be encouraged.

Although using information technology (IT) for interventions have often been sidelined in the past and considered inadequate, the evidence now suggests that both preventative and management measures can be delivered remotely and cost-effectively with high levels of engagement and client satisfaction (Cohen et al., 2012). IT has been utilized in a number of ways; virtual parenting groups allows parents and professionals to share information and interventions for children with eating disorders. Behaviour management though personalized digital packages aimed at changing responses are being developed. Weight loss, healthy food choices, and increased physical activity have been successfully achieved in adolescents in the short term, with improvement in BMI and lifestyle changes (Fedele et al., 2017). Teenagers have successfully increased their physical activity with the aid of mobile applications (Seah and Koh, 2020) and virtual groups in New York have had positive outcomes regarding increasing physical activity (Woo Baidal et al., 2020). The regular monitoring of weight at home using electronic

Table 1

| Childhood obesity prevention and management recommendations during COVID-19 pandemic. |
|---------------------------------|
| **RECOMMENDED INTERVENTIONS REQUIRED FROM STAKEHOLDERS** |
| Government/Regulators |
| Scale up childhood obesity prevention policies (Pietrobelli et al., 2020; Vidgen et al., 2018; Wang and Lobstein, 2006). |
| Deliver advertising promoting healthy choices during lockdown (Radesky et al., 2020). |
| Maintain services for childhood obesity prevention (Inchley et al., 2016). |
| Increase and support research that look at consequences of extended school closures on obesity. (Radesky et al., 2020; Rundle et al., 2020). |
| Healthcare providers |
| Adopt service delivery that is cost-effective and COVID-19-secure by using telehealth to deliver services (Cohen et al., 2012; DelSilva and Vaidya, 2020; Fedele et al., 2017; Woo Baidal et al., 2020). |
| Support creativity in families by providing activity packs (Tan and Holub, 2011). |
| Consider modular teams for continuity of services (Hiatt et al., 2012). |
| Make mental health services available for children as well as their parents (Zhang et al., 2020). |
| Provide vulnerable families with activity packs that will help decrease screen time (Tan and Holub, 2011). |
| Provide virtual parenting lessons aimed at behavior change (Woo Baidal et al., 2020). |
| Utilize self-weighing with e-scales alongside weight management discussion. (Johansson et al., 2020). |
| Offer relationship counseling to reduce family breakdown. (Woo Baidal et al., 2020). |
| Schools |
| Prioritize physical education alongside traditional subjects during lockdown (Rundle et al., 2020). |
| Require daily physical activity within school hours (Rundle et al., 2020). |
| Integrate physical movement into routine lessons (Rundle et al., 2020). |
| Social media, influencers, and technology |
| Work with governments to enhance healthier advertising options (Khajehheian et al., 2018). |
| Create age-appropriate apps that encourage physical activity (Khajehheian et al., 2018; Partridge and Redfern, 2018; Seah and Koh, 2020). |
| Create video games that discourage and decrease physical inactivity (Khajehheian et al., 2018; Woo Baidal et al., 2020). |
| Provide mindfulness apps and virtual reality technology (Seabrook et al., 2020). |
| Utilize the appeal of apps and capitalize on their use to promote behavior change (Shomaker et al., 2015; Partridge and Redfern, 2018). |
| Families |
| Develop and encourage virtual education for parents to promote breastfeeding, discourage early weaning, and encourage appropriate portion sizes for infants and children and healthy food choices (Skelton et al., 2020). |
| Self-monitor physical activity and nutritional intakes and set goals (Griffiths et al., 2010; Skelton et al., 2020). |
| Focus and increase parents’ role modeling of healthy lifestyles, physical activity, and healthy food choices (Griffiths et al., 2010; Skelton et al., 2020). |
| Encourage children to join their parents when they go out for daily allowed exercise or walks during lockdown (Skelton et al., 2020). |
scales that transfer data to mobile applications is associated with a greater reduction in weight along with positive patient experience (Johansson et al., 2020). The development of more culturally sensitive and appealing presentations directed at behavioural change and health promotion will engage our target audience and encourage perseverance. The smart use of personalized apps can encourage behavioral change even when children are confined to their homes.

IT or “Telehealth” can overcome many barriers associated with limited patient resources (Davis et al., 2020; Woo Baidal et al., 2020). Telehealth bypasses non-engagement because of travel issues or costs and possibly reduces patient embarrassment due to lack of visual contact. Furthermore, the evidence indicates that the feeling of being judged reduces clients’ trust in their healthcare providers (Pont et al., 2017); and virtual services may circumvent this emotion and enhance engagement. “Telehealth” allows sustained continued remote care despite COVID-19 restrictions and limitations (Davis et al., 2020).

Table 1 places the complex biopsychosocial interactions that need to be considered when managing weight gain are considered along side necessary involvement of stakeholders to ensure a cohesive and effective response. Due to the very nature of the BPS model, the response needs to be multifaceted, multidisciplinary and involve a wide range of interested parties. An accurate understanding of the biopsychosocial interactions that contribute to weight gain and weight management, properly applied, will support more effective management of weight gain during and beyond the pandemic.

5. Implications for practice

The family, community, home and school environments have changed in unimaginable ways during the COVID-19 pandemic. The juxtaposition of another pandemic, that of childhood obesity, has created a perfect storm, increasing the risk of developing adiposity as well as worsening pre-existing obesity (Browne et al., 2021). Socioeconomic, psychosocial, cultural, genetic, behavioral, psychological, and environmental factors all play a part (Hiatt et al., 2012) similar to other chronic diseases (Khan et al., 2020). COVID-19 has had a significant impact on many of these variables (Fig. 1). emphasizes the complex biopsychosocial interactions that need to be considered when managing weight gain.

Although there is no quick fix that can solve all weight management problems in children during the pandemic, interventions can still be delivered while adhering to social distancing and lockdown rules, especially through novel channels such as telehealth and software applications. However, technology alone is not enough. Close communication between parents, schools, and communities will allow integrated care, even when further lockdowns or school closures cause stress for children; this important role shows us that we must provide adequate funding for the initiatives described above.

The COVID – 19 pandemic has amplified the need for an integrated interdisciplinary approach to weight management. The collision of both the obesity and the COVID-19 pandemic due to an abrupt and dynamic

Fig. 1. Biopsychosocial factors that influence COVID -19 pandemic related obesity in children.
change in the biopsychosocial environment has put children at an increased risk of obesity and, therefore, at increase risk of serious COVID-19 disease (Browne et al., 2021). To produce effective programs that will both prevent and combat childhood obesity, governments, public health organizations, educational establishments, primary health teams, and local communities must be engaged. It is essential that all stakeholders review critically the biopsychosocial needs of our children. Such an approach will aid in significantly reducing the negative impact of obesity and COVID-19 (Browne et al., 2021).

Patient consent for publication
Not required.

Ethics approval
Not required.

Authors contributions
MT, MAB contributed to the conceptualization and carried out the literature review. MT, MAB and JEMS contributed to the writing of the review and editing of all the drafts. All authors read and approved the final version.

Funding
No funding was involved in the preparation of this review.

Declaration of competing interest
None declared.

Acknowledgment
None.

References
Al Falasi, R.J., Ab Khan, M., 2020. The impact of COVID-19 on Abu Dhabi and its primary care response. Aust. J. Gen. Pract. 49 https://doi.org/10.31128/AJGP-COVID-35.
Balanzá-Martínez, V., Atienza-Carbonell, B., Kapczinski, F., De Boni, R.B., 2020. Lifestyle behaviours during the COVID-19 time to connect. Acta Psychiatr. Scand. 141 (5), 399–400. https://doi.org/10.1111/aps.13177.
Brancum, P., Kaye, G., Sucup, P., Sharma, M., 2010. An evaluation of holiday weight gain among elementary-aged children. J. Clin. Med. Res. 2 (4), 167–171. https://doi.org/10.4021/jcmr414w.
Browne, N.T., Snethen, J.A., Greenberg, C.S., Frenn, M., Kilanowski, J.F., Gance-DeSilva, S., Vaidya, S.S., 2020. The application of telemedicine to pediatric obesity: lessons from the past decade. Telemedicine and e-health. https://doi.org/10.1089/teh.2018.0314.
Di Pietro, G., Biagi, F., Costa, P., Karpiniski, Z., Mazza, J., 2020. The likely impact of COVID-19 on education. Reflections Based on the Existing Literature and International Datasets, 30275. Publications Office of the European Union, Luxembourg, https://doi.org/10.2760/125666.
Díaz-Zavalía, R.G., Castro-Cantú, M.F., Valencia, M.E., et al., 2017. Effect of the holiday season on weight gain: a narrative review. J. Obes. 2017, 2085136 https://doi.org/10.1155/2017/2085136.
Dunn, C.G., Kenney, E., Fleischhacker, S.E., Bleich, S.N., 2020. Feeding low-income children during the covid-19 pandemic. N. Engl. J. Med. 382, e60. https://doi.org/10.1056/NEJM20200538.
Eisenmann, J.C., Gundersen, C., Lohman, B.J., Garasky, S., Stewart, S.D., 2011. Is food insecurity related to overweight and obesity in children and adolescents? A summary of studies, 1995–2009. Obes. Rev. 12 (5), e73–e83. https://doi.org/10.1111/j.1467-789X.2010.00820.x.
Engel, G.L., 1978. The biopsychosocial model and the education of health professionals. Ann. N. Y. Acad. Sci. 310, 169–181. https://doi.org/10.1111/j.1758-4664.1978.tb09928.x.
Erikson, J.G., Forsen, T.J., Osmond, C., Barker, D.J.P., 2003. Pathways of infant and childhood growth that lead to type 2 diabetes. Diabetes Care 26, 3006–3010. https://doi.org/10.2337/diacare.26.11.3006.
Fedele, D.A., Cashing, C.C., Fritz, A., Amaro, C.M., Ortega, A., 2017. Mobile health interventions for improving health outcomes in youth. JAMA Pediatr. 171, 461–469. https://doi.org/10.1001/jamapediatrics.2017.0042.
Fiese, B.H., Hammons, A., Grigsby-Tousignant, D., 2012. Family mealtime: a contextual approach to understanding childhood obesity. Econ. Hum. Biol. 10 (4), 365–374. https://doi.org/10.1016/j.ehb.2012.04.004.
Finnell, C., 2020. Obesity, COVID-19 and immunotherapy: the complex relationship! Immunotherapy 12, 1105–1109. https://doi.org/10.2217/imt-2020-0178.
Franckle, R., Adler, R., Davison, K., 2003. Accelerated weight gain among children during summer versus school year and related racial/ethnic disparities: a systematic review. Prev. Chronic Dis. 11 https://doi.org/10.5888/pcd11.030055.
Gabbett, C., Donohue, M., Arnold, J., Schwimmer, J.B., 2010. Adenovirus 36 and obesity in children and adolescents. Pediatrics 126, 721–726. https://doi.org/10.1542/peds.2009-3963.
Gouveia, M.J., Canavarro, M.C., Moreira, H., 2019. Associations between mindfulness, self-compassion, difficulties in emotion regulation, and emotional eating among adolescents with overweight/obesity. J. Child Fam. Stud. 28, 273–285. https://doi.org/10.1007/s10826-018-0924-9.
Grant, W.B., Lahore, H., McDonnell, S.L., Baggerly, C.A., French, C.B., Aliano, J.L., Bhattos, H.P., 2020. Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. Nutrients 12. https://doi.org/10.3390/nu12096884.
Griffiths, L., Hawkins, S., Cole, T., Deazeutx, C., 2010. Risk factors for rapid weight gain in preschool children: findings from a UK-wide prospective study. Int. J. Obes. 34, 624–632. https://doi.org/10.1038/ijo.2010.10.
Hawkins, S.S., Cole, T.J., Law, C., Group, the, M.C.S.C.H., 2009. An ecological systems approach to examining risk factors for early childhood overweight: findings from the UK Millennium Cohort Study. J. Epidemiol. Community Health 63, 147–155. https://doi.org/10.1136/jech.2008.079917.
Hiatt, K., Riebel, L., Friedman, M.L., 2012. The need to treat childhood obesity with holistic methods: why pediatric endocrinologists do not use multifactorial treatment. Humanist. Psychol. 40 (4), 308–312. https://doi.org/10.1108/10610201211240897.
Ikedie, F.I, and Isakwu, N.D., 2018. The use of Cowpea (Vigna unguiculata L. Walp) in the preparation of breakfast porridge in Nigeria: A preliminary study. Int. J. Pediatr. Endocrinol. 2018: 10, 21.
Ikedie, F.I, and Isakwu, N.D., 2018. The use of Cowpea (Vigna unguiculata L. Walp) in the preparation of breakfast porridge in Nigeria: A preliminary study. Int. J. Pediatr. Endocrinol. 2018: 10, 21.
Ikedie, F.I, and Isakwu, N.D., 2018. The use of Cowpea (Vigna unguiculata L. Walp) in the preparation of breakfast porridge in Nigeria: A preliminary study. Int. J. Pediatr. Endocrinol. 2018: 10, 21.
Ikedie, F.I, and Isakwu, N.D., 2018. The use of Cowpea (Vigna unguiculata L. Walp) in the preparation of breakfast porridge in Nigeria: A preliminary study. Int. J. Pediatr. Endocrinol. 2018: 10, 21.
Ikedie, F.I, and Isakwu, N.D., 2018. The use of Cowpea (Vigna unguiculata L. Walp) in the preparation of breakfast porridge in Nigeria: A preliminary study. Int. J. Pediatr. Endocrinol. 2018: 10, 21.
