

Institution: London Metropolitan University		
Unit of Assessment: 3 Allied Health Professions, Dentistry, Nursing and Pharmacy		
Title of case study: Improving obesity and metabolic risk assessment in children		
Period when the underpinning research was undertaken: 2000-2013		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
H. David McCarthy	Professor of Nutrition & Health	1995-present
Period when the claimed impact occurred: 1/8/2013 – 31/7/2020		
Is this case study continued from a case study submitted in 2014? Y		

1. Summary of the impact (indicative maximum 100 words)

Excess body weight has become an entrenched factor in contemporary society. It drives increased morbidity and mortality. Managing the condition as well as finding better ways to assess obesity-related ill health have remained global challenges in the 21st century. Prof David McCarthy's research has continued to provide novel tools for health practitioners to support the prevention, assessment and treatment of childhood obesity, addressing both the physical and mental health and well-being of the child, through the WC tool and the Lottie doll. This research has additionally encouraged development of girls' interest in STEM subjects through space exploration.

2. Underpinning research (indicative maximum 500 words)

The underpinning research to this impact case study is a continuation of the work led by Prof. David McCarthy at this institution beginning in the mid-to late 1990s. This was at the start of the rapid increase in childhood obesity prevalence in the UK, highlighting the necessity for improved assessment tools. Having identified that abdominal obesity was more strongly related to metabolic risk in children compared with general obesity (assessed using the body mass index (BMI)), he developed the first set of national references for waist circumference (a proxy for abdominal adiposity) in 2001 [R1]. These pioneering references, taking the form of centile charts, have now been in use for close to twenty years and in 2020 remain the sole national references for this measure of obesity and are as such used widely across the UK [R2].

This research challenged then current thinking and practice in childhood obesity and metabolic assessment. In the NICE 2006 guidelines for the assessment of overweight and obesity in children, the body of health and care excellence acknowledged and guided practitioners that waist circumference 'may be used to give additional information on risk and developing long term health problems' (NICE CG43, 2006). Following our publication of the British references in 2001, there is now a global collection of national waist circumference references for children including several major populations including Malaysia, Germany and Poland.[R3] This global expansion is an endorsement of the importance of abdominal adiposity as key to identifying risk for metabolic disease in children.

Demonstrated as early as 2003 that in contrast to generalised obesity, abdominal obesity (assessed by the definitive waist circumference centile charts) had increased in UK children and youths at a far greater rate [R3], other researchers have built upon McCarthy's pioneering

observations to show using Health Survey for England data that abdominal obesity continues to increase in young people in the UK (Mindell et al. 2012).

McCarthy's innovative obesity assessment research further evolved to develop additional and more novel sets of childhood clinical charts: to assess total body fatness – the component of body composition directly associated with morbidity and skeletal muscle mass charts to indicate the risk of sarcopenia and metabolic disease [R4, R5]. These charts, which were produced in collaboration with eminent UK obesity researchers (Prof. Susan Jebb, University of Oxford and Prof. Andrew Prentice, London School of Hygiene & Tropical Medicine) with funding from Tanita EU, have enabled a greater evaluation of the role of stature (height) on the prevalence of overweight and obesity in children – an aspect of research evaluated in this submission. While strong socio-economic influences have been observed, such findings have reinforced the validity of the waist-to-height ratio (WHtR) originally proposed by McCarthy and Ashwell as a simple public health assessment tool in children [R6].

This research has created a foundation for the application of these tools to specific scenarios as well as academic thinking on the relationship between growth, development, and body fat accumulation during childhood and adolescence. Specifically, it has provided opportunities to further develop and refine the assessment tools in light of new knowledge on body composition-related risk for cardiometabolic diseases in children. This research has allowed us to address specifically the influence of socioeconomic status on the validity and application of obesity assessment tools, as well as to generate charts for specific ethnic groups including children from a south Asian background.

3. References to the research (indicative maximum of six references)

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- R1. McCarthy HD, Jarrett KV, Crawley HF (2001). The development of waist circumference percentiles in British children aged 5.0-16.9 y. *Eur J Clin Nutr* **55**, (10):902-7. DOI: 10.1038/sj.ejcn.1601240 <https://0-www-nature-com.emu.londonmet.ac.uk/articles/1601240.pdf>
- R2. McCarthy HD (2017) Assessment of nutritional status in public health settings. Nutrition Society textbook series – Public Health Nutrition, 2nd ed. ISBN 9781118660973 OCLC ocn966436445 <https://www.dawsonera.com/readonline/9781118660935/startPage/45/1>
- R3. McCarthy HD (2014). Measuring growth and obesity across childhood and adolescence, *Proc Nutr Soc* **73**, 210-217. DOI: 10.1017/S0029665113003868 Presented at The Nutrition Society Irish Section Meeting on 19–21 June 2013 <https://0-www-cambridge-org.emu.londonmet.ac.uk/core/services/aop-cambridge-core/content/view/6B90450036A955DADD78C3F99CE4BFB3/S0029665113003868a.pdf/div-class-title-measuring-growth-and-obesity-across-childhood-and-adolescence-div.pdf>
- R4. McCarthy HD, Cole TJ, Fry T, Jebb SA, Prentice AM (2006). Body fat reference curves for children. *Int J Obes (Lond)*; **30**, 598-602. DOI: 10.1038/sj.ijo.0803232 <https://0-www-nature-com.emu.londonmet.ac.uk/articles/0803232.pdf>
- R5. McCarthy HD, Samani-Radia D, Jebb SA & Prentice AM (2013). Skeletal muscle mass reference curves for children. *Ped Obesity* **9**, 249-259. <https://onlinelibrary.wiley.com/doi/abs/10.1111/j.2047-6310.2013.00168.x>
- R6. McCarthy HD, & Ashwell M (2006). A study of central fatness using waist:height ratios in UK children and adolescents over two decades supports the simple message – 'keep your waist circumference to less than half your height'. *Int J Obesity* **30**, 988-992. DOI: 10.1038/sj.ijo.0803226 <https://0-www-nature-com.emu.londonmet.ac.uk/articles/0803226.pdf>

4. Details of the impact (indicative maximum 750 words)

Since 2013, Prof. McCarthy's research on improved assessment tools for children has continued to generate impact, in clinical practice, industrial applications and in health policy.

i) Clinical practice. Weight management services continue to be the front-line approach to helping children achieve a healthier weight. In its guidance "Childhood obesity: applying All Our Health" (May 2020), Public Health England (PHE) notes *"Obesity is associated with poor psychological and emotional health, and many children experience bullying linked to their weight."* Health service providers in the UK continue to routinely use McCarthy's waist circumference (WC) centile charts during assessment as a measure of abdominal fatness. These charts are also used educationally with children and parents, illustrating how outcomes have improved by focusing on abdominal fatness. For example, a focus on waist rather than weight has helped remove the stigma associated with weighing.

The SHINE Health Academy (SHINE) is a not-for-profit community organisation helping young people to lose weight and to improve their self-esteem and confidence. Managing Director, Kath Sharman, observes that sensitivity is required when *"providing services for obese children and young people (CYP)."* While research *"recommendations on outcome measures used in obesity management are primarily targeted towards adult cases,"* [S9] consideration has often not been given to how the use of these same measures and techniques could result in damaging outcomes for children. Typically, weighing can be associated with judgmental feelings, negative perceptions of a child's diet and lifestyle and can lead on to social isolation and lower participation in exercise. Quality of life, including self-esteem, can then become negatively affected through weight bias. Sharman notes that McCarthy's research provided *"alternative ways of undertaking outcome measures that would be more sensitive to the needs of children."* SHINE has replaced weight measure and BMI calculations as its primary measurement tools, and now ensures that its *"care and treatment plans are led more by the waist measure recordings and [they] encourage the young people to chart these themselves, so that they can take personal responsibility"* for their own care and development. Sharman endorsed McCarthy's charts, saying that *"we find waist measures are non-intrusive and easy to interpret and also non-stigmatising."* [S9]

In addition to its service supporting individuals, SHINE has designed an activity leaflet for use by schools in PSHE sessions. This tool, based on McCarthy's charts, allows children and their teachers to address childhood obesity in a *"fun and interactive way"* and enables children *"with a significant waist increase, an indication that a medical assessment may be of benefit, [to] be referred to [SHINE] without blame, judgement or embarrassment."*[S9]

ii) Industry/commercial.

In 2010, the founders of Arklu, a doll manufacturing company based in London, in recognising the increase in demand for dolls that are a *"more realistic representation of the children playing with the toys"* became *"the first doll company to address body image and the problems that it causes."*[S4]

The launch in 2012, following an 18 month consultation using McCarthy's research on children's healthy body shape, of the innovative Lottie doll based on the average proportions of a nine-year-old child instead of the more traditional doll model of an adult woman paved the way for a significant expansion of Arklu's business. With sales of the doll exceeding 1,000,000 worldwide, in 2014 Arklu relocated the business, including production, from London to Donegal, Ireland, an area

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with 24% unemployment at that time. By November 2020, the company employed 6 people [S4]. Based on McCarthy's research, the Lottie doll range has since August 2013 evolved ethically to address positive body image, bullying, promoting diversity and gender equality [S4] and to encourage girls' participation in STEM subjects. In 2013, Arklu launched a boy doll (Finn) and as Ian Harkin, Managing Director of Arklu reports, they "*returned to Prof McCarthy for the measurements for a boy aged nine.*" As McCarthy's research demonstrated that the proportions of a nine year old boy are similar to those of a girl of the same age, the cost savings for Arklu were significant as this "*meant that the company did not have to tool up a second doll body which saved the company [USD]36,000 in tooling costs.*" The ability to use the same doll body also facilitated the company's aim to "*address gender stereotypes. [They] have named all of the dolls' outfits and accessories under the gender neutral label 'Lottie and Finn' as opposed to just 'Lottie.'*"[S4] The range now includes 50 dolls each inspired by children, including Finn the Loyal companion boy doll based on an eight-year boy with autism. On the launch of this doll in 2018, BBC News reported on Arklu's key principle that "*childhood should be an inclusive place, where every child belongs regardless of gender, ethnicity or ability.*" The boy's mother told BBC News "*The doll is there now for children across the world who might have autism. It also gets the message out there to children who don't.*"[S10]

Having received 35 international awards in the USA, UK and Canada, including in 2016 Gold Independent Toy Award and in 2017 an International Design Award, plus international press coverage in The Guardian, New York Times, Forbes Magazine, Sydney Morning Herald amongst many others, sales of the dolls expanded into over 30 countries and 3000 stores between 2013-2016 and by November 2020 2,500,000 units have been sold. [S4]

The Stargazer doll, developed in conjunction with the European Space Agency (ESA), was inspired by an outfit design by a 6 year old Canadian girl interested in astronomy. In December 2015, the Stargazer doll travelled aboard the Orbital ATK's S.S. Deke Slayton II Cygnus cargo spacecraft with ESA astronaut Tim Peake to the International Space Station, spending 264 days in orbit [S4, S5], inspiring a generation of girls in STEM. Harkin said "*Space travel is all about pushing boundaries and trying to get the next generation interested in science subjects, so we thought [sending the doll to space] was the perfect fit,*" [S5]. Consequently, 13-year-old aspiring astronaut Taylor Richardson featured in a video campaign to be the first African American woman to travel to Mars. Richardson commented how she was attracted by a doll who was into STEM and space, describing her as "*diverse, unique, powerful and inspiring*" [S8].

Benita Mehra, president of Women in Engineering and Science (WES) has stated "*Lottie drew attention to engineering and where women work in technical roles in a way that was magical. We know it had a huge impact with tweets and social media*".[S6] Annually between 2016-2020, as a promotional tool to encouraging girls into STEM subjects, the Lottie doll participated in five successive Tomorrow's Engineers Week, organised by Women in Engineering. The WES Lottie Tour aims to "*inspire and encourage young girls (and boys) to think of careers in engineering and STEM subjects to be open to everyone,*" and has travelled across the globe including the UK, USA, Malawi and Antarctica [S6]. In 2020, the WES Lottie tour incorporated a virtual aspect emphasizing the ability of engineers to adapt their working environments during the Covid-19 pandemic. [S6]

iii) Health policy.

In its 2016 guidance on the management of psychosis and schizophrenia in children and young people (CG155, 2016), the National Institute for Health and Care Excellence (NICE) recommends the use of McCarthy's WC centile charts to monitor potential weight gain side effects prior to and at

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regular (6 monthly) intervals during treatment. As the guidance notes, *“There are also concerns that children and young people are more sensitive than adults to the potential adverse effects of antipsychotics, including weight gain, metabolic effects and movement disorders.”* [S1 p36] Such side effects of medication as unintentional weight gain particularly with excess body fat distributed abdominally may create further additional psychological stress. The measurement of the waist is used to help manage the side effects and potential negative impacts on mental health of the weight gain in a less stigmatising and potentially damaging method such as weighing.

In 2017, the International Diabetes Federation (IDF) reported that with a quarter of the world’s adult population suffering from metabolic syndrome, the *“condition is appearing with increasing frequency in children and adolescents, due to the growing obesity epidemic.”* People with the syndrome are *“two to three times as likely to have a heart attack or stroke and five times as likely to develop type 2 diabetes.”* [S2 p3] In an expansion of the definition to assess adults at risk, the IDF consensus definition of the metabolic syndrome in children recognised the greater sensitivity of waist measurement for metabolic disease risk. Indeed, making waist circumference an essential criterion for diagnosis, places a far greater emphasis on abdominal obesity superseding BMI measurement as one key diagnostic criterion. [S2 p8] The IDF have therefore mandated that national waist circumference references must be used, which in the UK means the charts produced by McCarthy as they remain the sole national WC reference available for the UK.

The government body for guidelines, the National Institute for Health and Care Excellence (NICE), continues to highlight that waist circumference measurement may be used to give *additional* information on risk of developing long-term health problems in children, their latest recommendation coming in 2014 [S3]. NICE guidelines mandate that waist measurement in children should only be interpreted and guidance offered through use of the national references. These guidelines dovetail with the adult NICE guidelines where health risks are based upon strict waist circumference cut-offs.

5. Sources to corroborate the impact (indicative maximum of 10 references)

- S1. NICE Guidelines CG155 (2016). Psychosis and schizophrenia in children and young people: recognition and management. <https://www.nice.org.uk/guidance/cg155>
- S2. IDF consensus definition of metabolic syndrome in children and adolescents. <https://idf.org/our-activities/advocacy-awareness/resources-and-tools/61:idf-consensus-definition-of-metabolic-syndrome-in-children-and-adolescents.html>
- S3. Obesity: identification, assessment and management: Clinical guideline 2014. <https://www.nice.org.uk/guidance/cg189>
- S4. Testimonial letter Arklu
- S5. <https://www.nbcnews.com/tech/innovation/first-doll-space-stargazer-lottie-joins-astronauts-aboard-iss-n488591>
- S6. Lottie Tour
- S7. <https://blogs.scientificamerican.com/voices/holiday-gift-guide-women-in-stem-fields-dolls-and-action-figures/>
- S8. <https://womenyoushouldknow.net/13-year-old-aspiring-astronaut-featured-lottie-dolls-inspired-real-kids-video-campaign/>
- S9. ‘Don’t waist Time’ leaflet and Testimonial letter SHINE Health Academy Ltd
- S10. BBC News story on launch of Finn, Loyal Companion, Doll <https://www.bbc.co.uk/news/uk-northern-ireland-foyle-west-45348537>