

A new BMI chart to mitigate the LMS ballooning phenomenon in UK90 growth charts

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INTRODUCTION

- **Accurate interpretation of weight and BMI trajectories** is essential to effective clinical monitoring.
- **UK90 reference curves** were modelled with the LMS method to fit the **-2.67 to +2.67 SD range**.
- In **clinical practice**, however, these curves are frequently used to monitor children whose weight/BMI can **extend well beyond +3 SD**.
- **Extending the LMS method** beyond this range causes the +3 SD and higher reference lines to “shoot up”¹ — termed “**ballooning**.”
- **Ballooning** causes high weight/BMI values to **cluster** into increasingly similar SDS values, creating a **compressed scale**.¹
- This **reduced clinical sensitivity** and non-linearity can make **interpretation difficult** and potentially **affect clinical decision-making**.
- **Key issue:** the **SDS scale becomes poorly aligned** with the way clinicians naturally interpret substantial **changes in weight/BMI**.

AIM

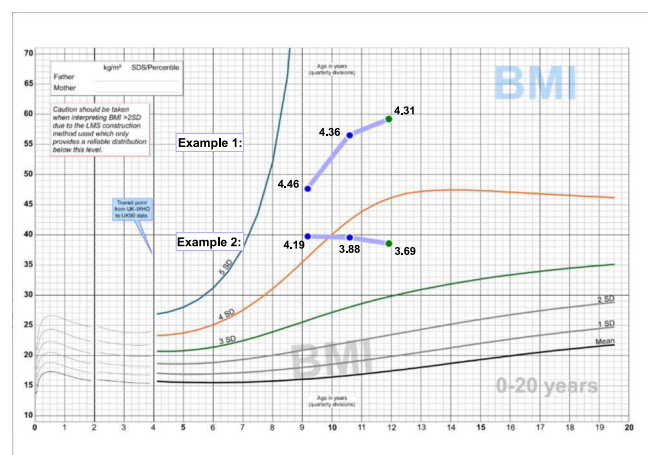
- Construct new weight and BMI charts to mitigate the inherent LMS ballooning in the UK90 data.
- Supporting greater clinical interpretability for decision making at extreme measurements.

METHOD

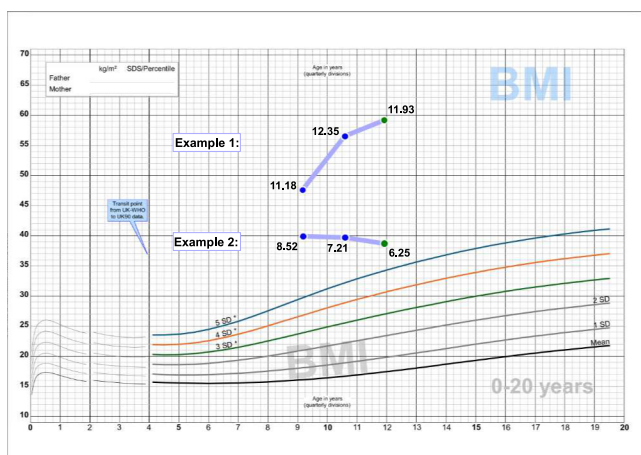
In the UK90 weight and BMI charts, familiar spacing between SD levels is seen until 2 SD but then rapidly increases exponentially. We applied established methods² to the UK 90 data; remodelling the SD levels above 2, assuming the BMI difference between 2 and 3 SD, 3 and 4 SD etc are equal to the BMI difference between 1,0 and 2,0 SD.

RESULTS

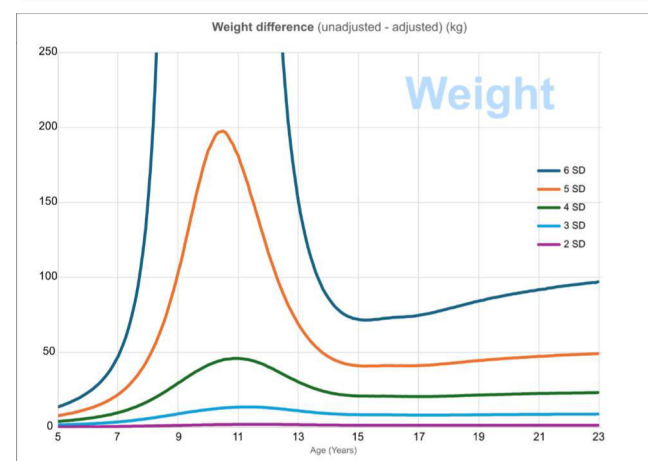
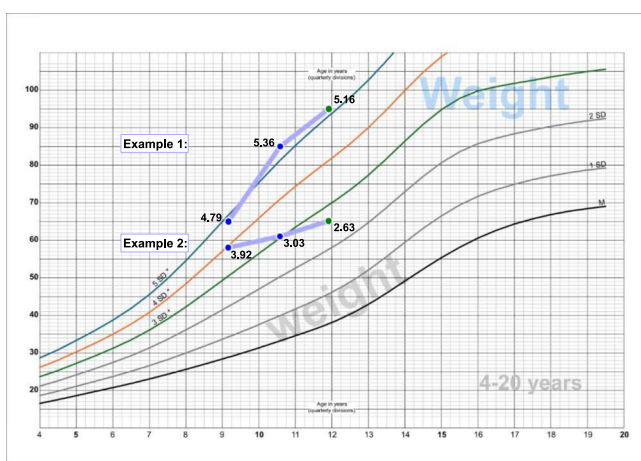
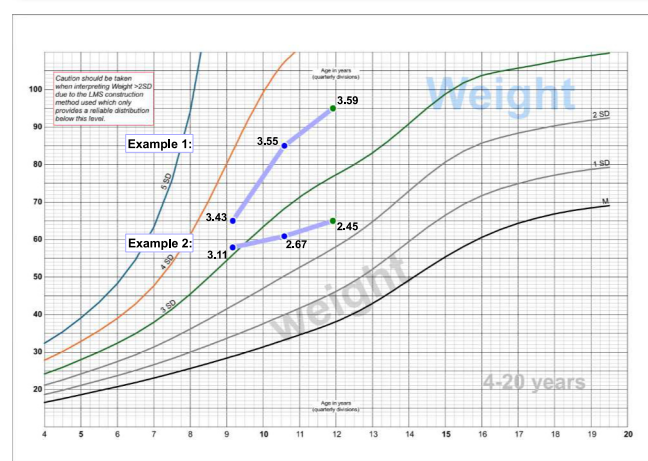
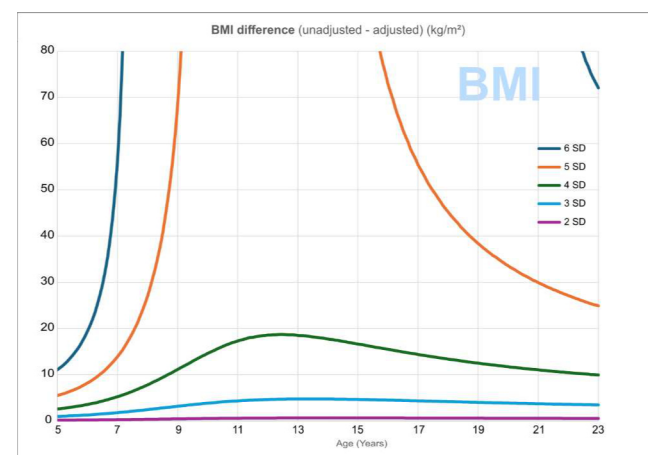
Unadjusted SD charts



Proposed SD charts



Measurement difference between charts



- On **unadjusted charts** extreme measures have **only moderately elevated SDS**.
- **Proposed charts improve the relationship between absolute values and their SDS**.
- On **unadjusted charts**, a **big increase** in absolute value may **unexpectedly result in a decrease in SDS**.
- **Proposed charts better reflect differences between extremities for absolute values and SDS**.

CONCLUSIONS

- When **constructing growth charts for clinical use** — particularly in the presence of positively skewed distributions — **explicit consideration** should be given to the treatment of extreme values.

Further work may include:

- Determining the **optimal approach** for selecting the SDS threshold at which such adjustments should be applied.
- Appraising the relative merits in usage with, and between, other **alternative approaches** e.g. % of 95th⁵, % above IOTF- 25⁶, half-normal resampling⁷.

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