Timing based clustering in the Northern Finland Birth Cohorts 1966 and 1986 suggests two new patterns for childhood BMI curve

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Background

Childhood body mass index (BMI) is a widely used measure of adiposity in children (<18 years of age).

Children grow with individual tempo and individuals of the same age, or of the same BMI, might be in different phases in their individual growth curves.

Variability between different childhood BMI curves can be separated in two components: phase variability (x-axis; time) and amplitude variability (y-axis; BMI).

Phase variability can be thought of arising from differences in maturational age between individuals. This is related to the timing of peaks and valleys in a child's BMI curve.

Are there latent groups of children with comparable childhood BMI growth phase?

Methodology

Data: Repeated measures of height and weight in the Northern Finland Birth Cohort 1966 (NFBC1966) and 1986 (NFBC1986), with 6715 females and 7204 males. Selection criteria of individuals with first measure before age of 6 months, last measure after age of 16 years, and subsequent measures taken under 5 years apart.

Pre-processing: Cubic (NFBC1986) and quadratic (NFBC1966) base splines were used to generate individual height and weight curves from one month to 16 years of age. Height and weight estimates were extracted from these data sets in 32 matching time points, and BMI estimates were calculated.

Distance measure: Cohorts were merged, and pairwise elastic phase-distances[1] of BMI curves were computed for individuals within data sets of males and females.

Clustering: Phase distances were used as the dissimilarity matrix in k-medoids approach with number of clusters k set between 2 and 10. Average silhouette widths were used to determine the optimal value for k, and similarity between clusters visualized by heatmap.

Results

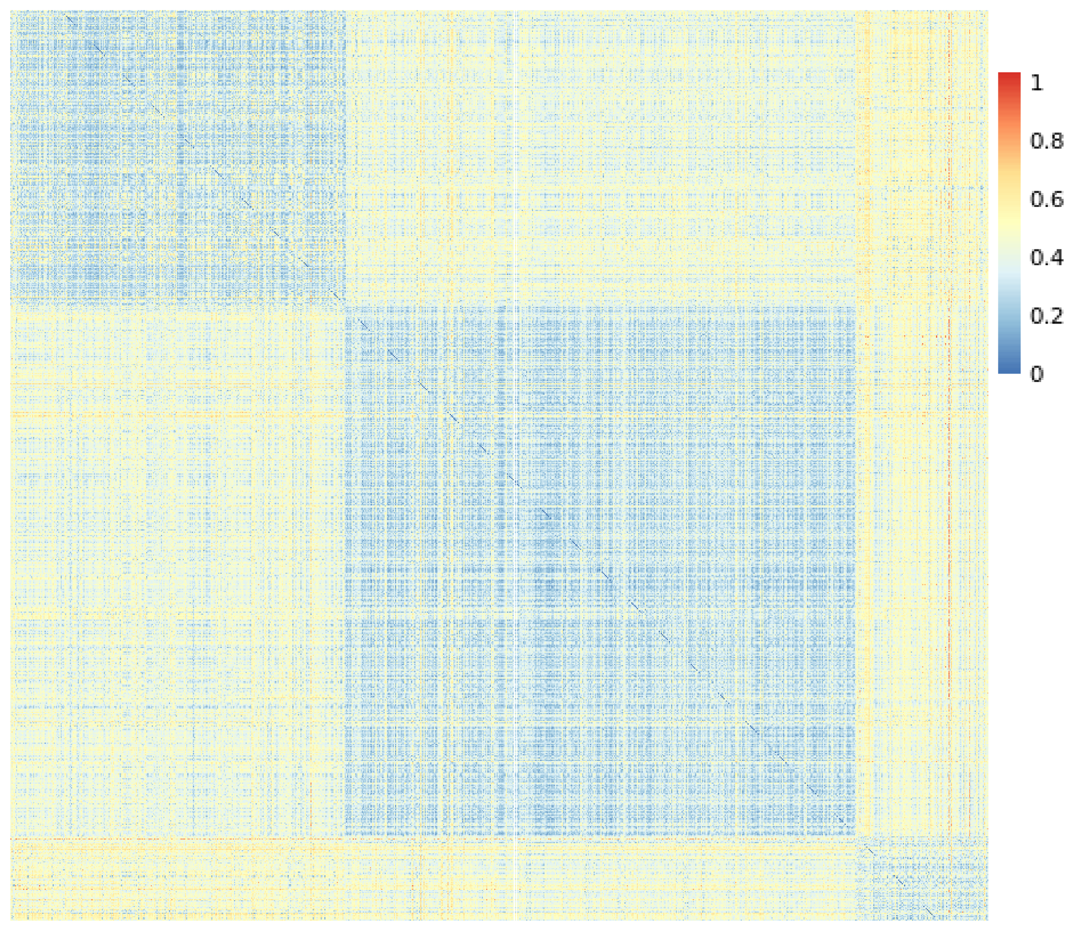

Figure 1: Cluster-wise ordered heatmap of phase distances between females with three clusters. Blue indicates distance close to 0.

After exclusions and combining cohorts, we analysed datasets of N=2999 females and N=3163. With females, average silhouette width was maximised with k=3 clusters, which showed good clusterability with visual inspection, see Figure 1.

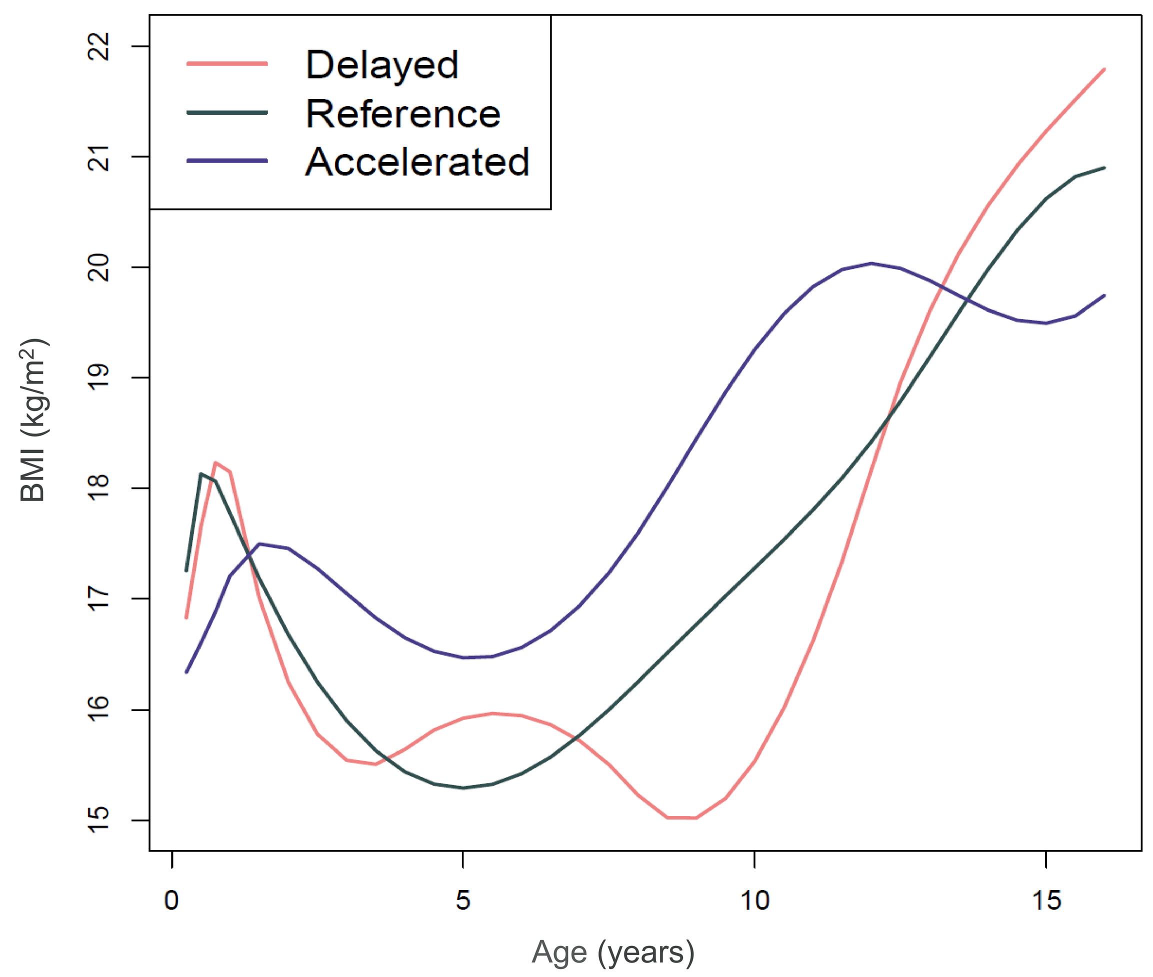

Figure 2: Median curves of the three clusters in females. The curves show characteristic shape of each cluster.

The characteristic BMI curves differed between the clusters and were named to describe the curve shape as "reference", "delayed" (long trough around the low point or even a double valley before pubertal spurt) and "accelerated" (rapid increase after the low point), see Figure 2.

Cluster description	Females N (%)	Males N (%)
Delayed	1028 (34.3)	973 (30.8)
Reference	1566 (52.2)	1669 (53.8)
Accelerated	405 (13.5)	521 (16.5)

Table 1. Cluster sizes and proportions in females and males.

"Reference" is the curve shape typically referred to as the childhood BMI shape in the literature. This was also the largest cluster in both sexes (Table 1).

Conclusions

We found three latent groups related to timing of childhood BMI. Characteristic curves of the groups were similar in both sexes.

Two of the groups, "delayed" and "accelerated" have not received much attention in previous literature. In future research, careful consideration should be given to the possible mismatch of maturational age and chronological age in studies related to BMI in children. More research is needed to replicate in independent cohorts and determine the possible health outcomes for the groups identified by this study.

The authors have no conflicts of interest to declare.

References

1. Tucker J.D., et al. Comput Stat Data Anal (2013). doi:10.1016/j.csda.2012.12.001

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