

Composition of Delayed Age at MPV of Weight Due to Unnatural Weight Gain

Ktsunori Fujii

Graduate School of Business Administration and Computer Science
Aichi Institute of Technology, Toyota-city, Japan

Nozomi Tanaka

Department of Sport and Health Science, Tokai Gakuen University, Japan

Kentaro Hayakawa

Early Childhood Studies, Nagoya Management Junior College, Japan

ABSTRACT

Age at maximum peak velocity (MPV) of weight may be affected by environmental factors that cause a gap with the age at MPV of height and a delay. However, the actual situation is not clear. In this study we analyzed the shift in the age at MPV in weight caused by the difficult, stressful environment following the Great East Japan Earthquake, based on the relationship between the ages at MPV of weight and height, which is thought to be a mechanism of natural growth. We also verified the mechanism of unnatural weight gain caused by the stress of the earthquake. We then determined the individual shift in the age at MPV of weight in a disaster group from a regression polynomial analysis of the age at MPV of weight against the age at MPV of height and examined the distribution state of the determined shifts. In this way, we derived evidence that the age at MPV of weight was shifted relative to the MPV age of height in girls in Fukushima Prefecture in the disaster group. This demonstrated that the effects from the Fukushima Prefecture nuclear power plant disaster were large, and also that there was a tendency for unnatural weight gain in junior high school girls in the region of Fukushima.

Keywords: Age at MPV of weight; Delay, Disaster; Age at MPV of height.

INTRODUCTION

The maximum peak velocity (MPV) of weight is a term used to indicate when body weight shows the highest rate of increase in puberty. It is a phenomenon detected by Fujii [1] by applying the wavelet interpolation model to body weight growth. The MPV for height is considered to be more of an indicator of physical maturity as a biological parameter, for which genetic factors are stronger, while the MPV of weight is affected more strongly by environmental factors. Therefore, there are cases in which increases in body weight from stress-induced lack of exercise during growth periods, such as the school years, as a result of restrictions on activity from earthquake disasters cause shifts in the growth velocity peak. In such cases, the age at MPV of weight may be delayed and give rise to a discrepancy with the age at MPV of height.

Discrepancies in the ages at MPV of height and weight are fundamentally thought to be time differences in the increase in weight associated with increasing height. That is, increases in body height end and body volume is fixed, and there may be a time difference until body weight is determined. For this discrepancy phenomenon, some years ago Lindgren [2] analyzed the discrepancies in the age of PHV of height and the age of PWV of weight in early, average, and late maturity. However, PHV and PWV are derived with a construction based on the amount of annual growth and calculating discrepancies in the age at the pubertal peak (age at MPV) in height and weight within individuals was difficult. Fujii et al [3] then analyzed the age at MPV of height and weight within individual athletes and general boys and girls. As a result, the discrepancy in the ages at MPV of height and weight was calculated to be a period of about 0.4–0.5 years in general boys and about 0.7–0.8 years in general girls. In athletes, the age at MPV of boys was about 0.2 years and the discrepancy in the age at MPV in girls was about 0.5 years, showing a significant difference with general boys and girls in the discrepancy in age at MPV. That is, discrepancies in the ages at MPV of height and weight in athletes were small, and the small-time difference in that discrepancy was thought to be due to weight increases without excess flesh in the physiques of athletes.

Therefore, if body weight increases occur due to human influences in the process of natural increases in body weight, there will be discrepancies in the age at MPV. However, standards are needed for judging those discrepancies.

Ueda and Fujii et al. [4] applied the wavelet interpolation model proposed by Fujii [1] to the longitudinal growth data for groups that had and had not been affected by the nuclear accident caused by the Great East Japan Earthquake, based on the two categories of areas that had received an evacuation advisory and other areas in the same year. Then, by examining the changes before and after the nuclear accident in age at MPV in growth during puberty, they analyzed the risks to physical growth from changes in the living environment after the earthquake disaster. According to these findings, the age at MPV for weight was shown to be delayed in people in areas that received an evacuation advisory. In other words, increased body weight from lack of exercise may be conjectured to have acted in the appearance of MPV for weight.

This gap of MPV age in weight is a gap with respect to the control group and is considered to be an average gap. In the case of an average gap, there are individuals in whom there is no gap. Therefore, unless the gap within the individual is used as a standard, it is not possible to judge that gap.

The MPV of weight taken up in this study refers to the pubertal peak in weight growth. It is the peak in weight gain associated with increasing height, a phenomenon that is thought of as a mechanism of natural growth. Therefore, a shift in MPV of weight suggests factors other than natural growth. Given this background, in this study we analyzed the shift in the age at MPV of weight due to the difficult, stressful environment following the Great East Japan Earthquake from the relationship with age at MPV for height, and clarifies a picture in which unnatural weight gain due to the unforeseen circumstance of lack of activity after the earthquake disaster leads to a delay in the MPV age for body weight.

METHODS

Subjects and materials

The control group was 4,659 girls from western Japan for whom full longitudinal height and weight growth data from the first grade of elementary school to the third year of junior high school (age 6–14) was collected. The group was limited to girls because it was thought that the MPV of height and weight could be detected in nearly all cases in junior high school, since the age at MPV in height and weight is earlier than in boys. The subject group consisted of 35 girls from the first grade of elementary school to the third year of junior high school (6–14 years old) in a certain junior high school in Fukushima Prefecture after the nuclear power accident in Fukushima Prefecture (2008–2016). After the aim of the study was fully explained, their height and weight recorded in growth measurements were used.

Analysis procedures

- 1) First, to identify the MPV of height and weight in the control group, the wavelet interpolation model was applied to the longitudinal growth data from the first year of elementary school to the third year of junior high school, and the age at MPV of height and weight was identified.
- 2) The wavelet interpolation model was applied to longitudinal growth data for height and weight of the junior high school students after the nuclear disaster in Fukushima Prefecture and junior high school students in the coastal region of Miyagi Prefecture, which were affected by earthquake disasters, from 6 to 14 years old. The age at MPV of height and weight was identified for the disaster group.
- 3) The statistics for the identified MPV were calculated, and the discrepancy in the ages at MPV in height and weight was calculated (Figure1). A comparison was then made of the control and disaster groups with respect to the discrepancy.
- 4) Next, a regression polynomial analysis was performed for the age at MPV of height, after which the order of the polynomial was determined. Judging from the coefficient of determination (R^2) in this study, and a second-order polynomial was adopted.

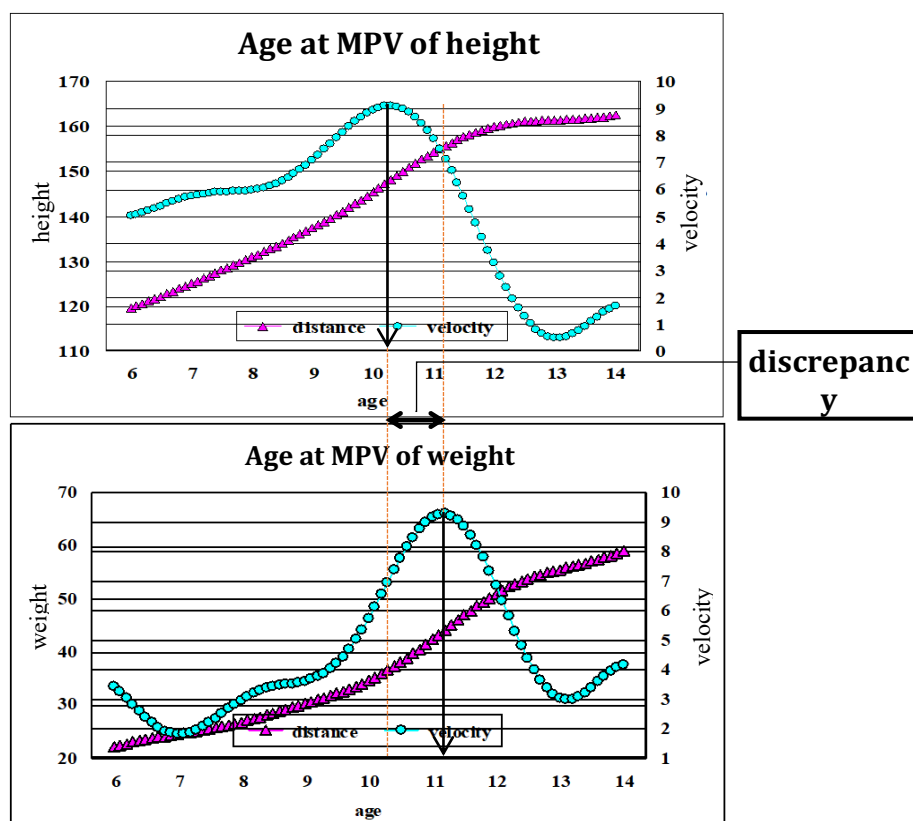


Figure 1. Display of discrepancy between age at MPV of height and weight

RESULTS

Construction of a regression evaluation chart of age at MPV of weight against age at MPV of height

Figure 2 shows the evaluation chart of a regression polynomial analysis attempted for the age at MPV of weight against age at MPV of height, but while first to third order polynomials fit, the third order was more effective according to the coefficient of determination and AIC. However, the difference with the second order was not that large, and so the second order was applied in this study. A lower order is judged to be valid if there is little change in the accuracy, and so in this study, second-order regression polynomials are thought to be valid. Figure 3 shows the frequency distribution when the control group data are fit on the regression polynomial evaluation chart derived from the control group, but normality is assured. The validity of the polynomial regression evaluation chart of the age at MPV of weight relative to the age at MPV of height was thus recognized.

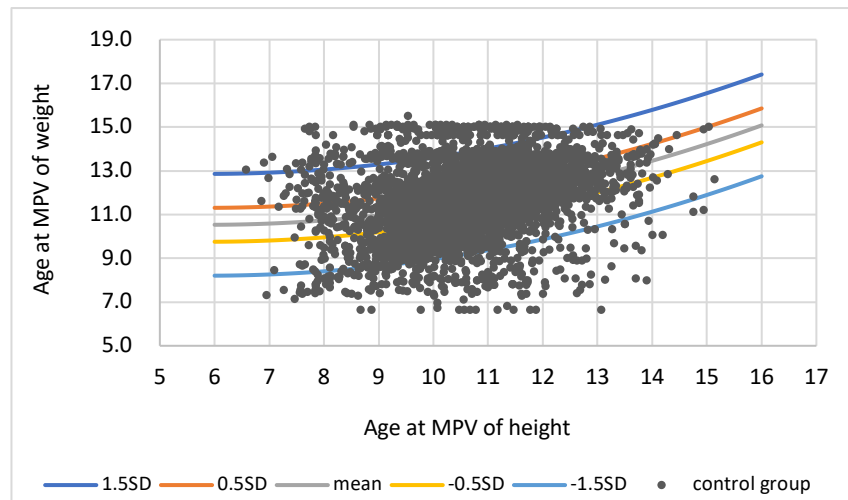


Figure 2. Regression polynomial evaluation chart derived from the control group.

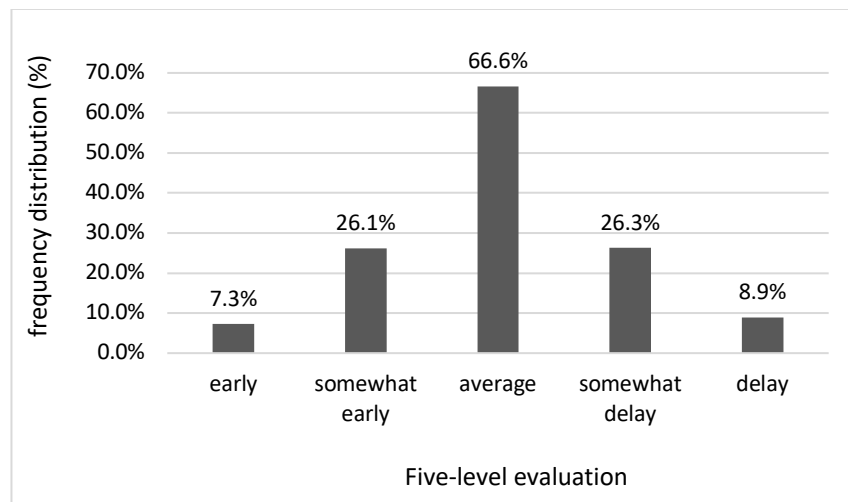


Figure 3. Frequency distribution in the control group.

Application of age at MPV of weight in disaster areas to polynomial regression evaluation chart

The data for both Miyagi Prefecture (Figure4) and Fukushima Prefecture (figure5) were fit to this regression polynomial evaluation. As seen in both graphs, evidence is shown that the age at MPV of weight is shifted relative to the age at MPV of height. In particular, it is seen that much of the distribution is in the somewhat delayed evaluation band (Figure6,7). This demonstrates that both disaster groups include many people with a shift in the age at MPV of weight. In particular, it is seen that the age at MPV is shifted more in the Fukushima Prefecture data distribution frequency. It became clear that the MPV age of individual weights was off from the MPV age of height, and it was found that unnatural weight gain occurred in the disaster areas.

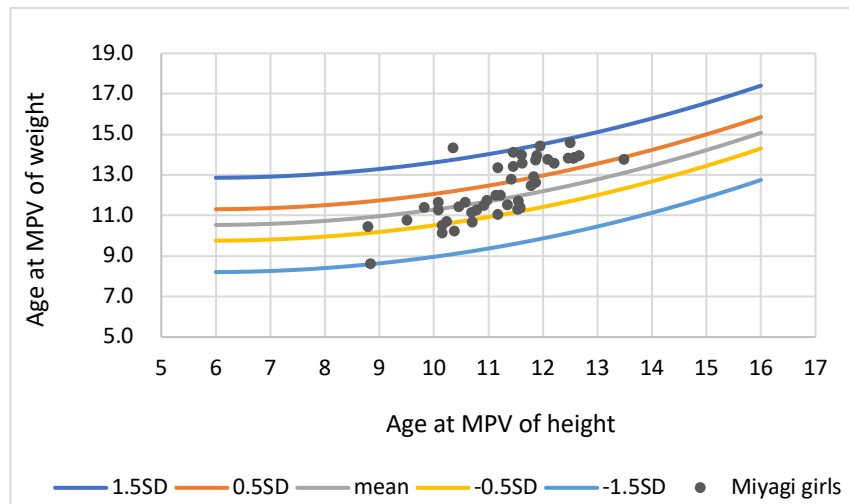


Figure 4. Fit to disaster group (Miyagi) regression polynomial evaluation.

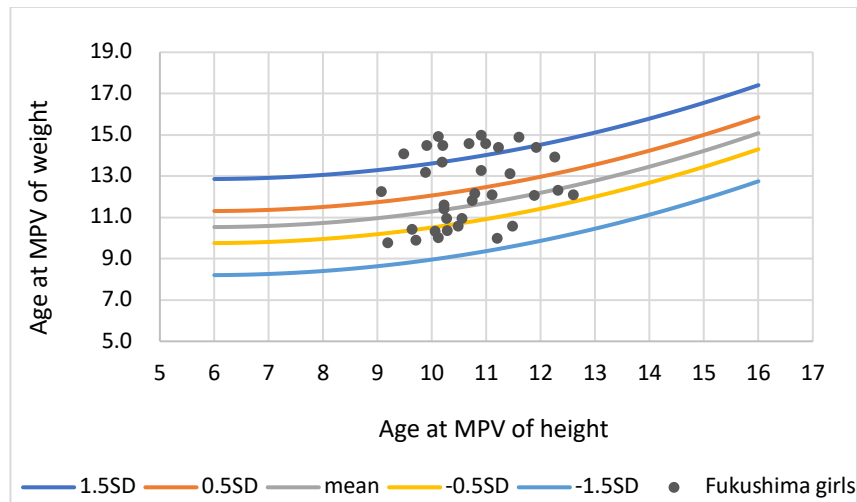


Figure 5. Fit to disaster group (Fukushima) regression polynomial evaluation.

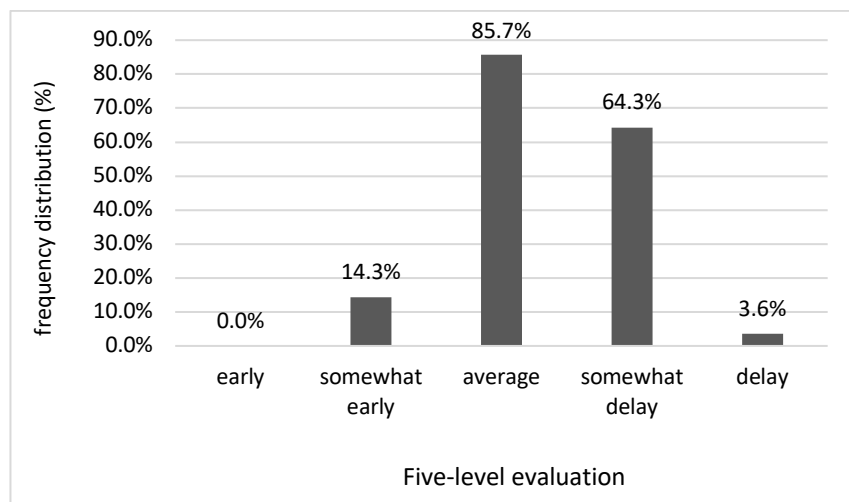


Figure 6. Frequency distribution in the disaster group (Miyagi).

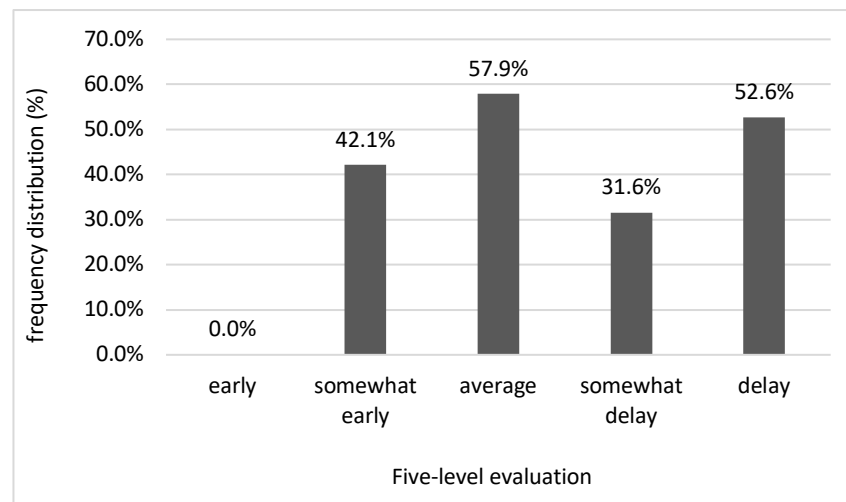


Figure 7. Frequency distribution in the disaster group (Fukushima).

DISCUSSION

The delay in the age at MPV of weight with respect to the age at MPV of height is a phenomenon in which the pubertal peak in previous natural weight gain is delayed as a result of unnatural weight gain or obesity. Discussions of this phenomenon may be based on the mean shift in ages at MPV of height and weight, but we must remember that this is just the mean shift. There are also individual cases in which no shift is seen. If the individual shifts in the ages at MPV of height and weight could be assessed, it would be possible to grasp unnatural weight gains from stress or lack of exercise in individuals. Therefore, we conducted a regression polynomial analysis of age at MPV of weight versus height. This idea is something Fujii [1, 5, 6] focused on from a regression analysis of age at menarche versus age at MPV of height in cases when there was a delay in menarche. In other words, when judging the delay in menarche from the discrepancy between age at MPV of height and age at menarche, a composition occurred in which the size of that discrepancy was no longer constant as the age at MPV of height increased. Accordingly, considering a composition in which this discrepancy is not constant, a regression polynomial analysis was adopted for age at menarche versus the age at MPV of height. In this way, it was possible to clearly identify delayed menarche in individuals.

In attempting to make individual judgments for the age at MPV of weight in this study, it is noted that the size of the discrepancy in the ages at MPV of height and weight would no longer be constant as the age at MPV of height increased, similar to when judging delayed menarche. Hence, a regression polynomial analysis of height at MPV of weight versus height was judged to be valid. When the data for the disaster group are applied to this regression polynomial evaluation chart, the delays in age at MPV of weight in individuals can be determined. In the Fukushima Prefecture disaster group, shown in Figure 5, the delay in age at MPV of weight is shown in the distribution frequency of Figure 7. When compared with the control group, a delay in the age at MPV of weight is certainly seen.

By constructing a regression polynomial evaluation chart for age at MPV of weight against height, individual delays in the age at MPV of weight can be identified.

Conversely, there are also cases when the age at MPV of weight is early. Satake et al [7] analyzed the relationship between the ages at the pubertal peak in height and weight, and discussed the order of appearance. In the normal order of appearance in the ages at the pubertal peak in height and weight, height is first and weight comes afterward, but they stated that there were also cases in which the order is reversed. Fujii and Kawanami [8] identified the ages at MPV in height and weight with the wavelet interpolation model, and analyzed the order. They reported the discrepancy in the ages at MPV of height and weight to be large in girls and reversal in the order in the age at MPV of both to be small. However, no findings have shown a composition in which the age at MPV in weight is delayed with respect to the age at MPV in height as in this study.

Considering the above findings, it would seem that some delays in the age at MPV of weight exist even normally, but a factor in that may be the increasing and decreasing changes in the weight growth of individuals. However, if individual factors are also included and that delay in the age at MPV in weight can be determined, the primary factor in the increasing and decreasing changes in body weight growth can be verified. Hence, the fact that unnatural weight increases due to a disaster were shown in this study from the delay in the age at MPV in weight in Fukushima Prefecture may be a very significant finding.

CONCLUSION

The MPV of weight taken up in this study indicates the pubertal peak in weight growth. It is the phenomenon of a weight gain peak associated with increase in height, which is thought of as a natural growth mechanism. Therefore, a shift in the MPV of weight suggests a factor other than natural growth. Given this, by verifying the delay in the MPV age of weight in Fukushima Prefecture, which is a disaster-stricken area, this study verified that unnatural weight growth occurs due to physical stress caused by the disaster. First, a regression polynomial evaluation chart of age at MPV of weight against age at MPV of height was constructed based on the control group. Then, the control group data were applied and the frequency distribution was shown, as a result of which normality was guaranteed. The Fukushima Prefecture data were then applied to this regression polynomial evaluation as the disaster group. As shown in the graph, this gives proof that the age at MPV of weight was shifted in relation to the age at MPV of height. In particular, it was found that much of the distribution was in the somewhat delayed evaluation band. Thus, it was demonstrated that the age at MPV of weight was shifted in many people in the disaster group. It can be said that an increase in unnatural weight growth in the affected areas was shown. At the same time, the effectiveness of the delayed weight MPV age evaluation chart was suggested.

References

- Fujii, K. (2006) A scientific approach to growth and development: Physical information science for growth and development & health, Sankeisha, Nagoya.
- Lindgren G (1978) Growth of schoolchildren with early, average and late ages of peak height velocity, *Annals of Human Biology*, 5, 253– 267.
- Fujii, K., Demura, S. and Matsuzawa, J. (2005) Optimum Onset Period for Training based on Maximum Peak Velocity of Height by Wavelet Interpolation Method in Japanese High School Athletes, *Journal of Physiological Anthropology and Applied Human Science*, Vol. 24, 15-22.
- Ueda, A., Fujii, K., Kani, Y., Tanaka, N. and Watanabe, T. (2018) Risk Analysis regarding Pubertal Peak of Physique by Effects of Fukushima Nuclear Power Accident, *Journal of Japan Society for Production Management*, 25(2), 131-136.
- Fujii, K. (2003) Verification regarding delayed menarche in Japanese female athletes: Analysis by wavelet interpolation method, *Japanese Society of Physical Education*, 48, 523-539.
- Fujii, K. (2008) Construction of Delayed Menarche Evaluation System in Japanese Female Athletes, *J. Educ. Health. Sci.*, 53(3), 273-285.
- Satake, T., Kikuta, F. and Ozaki, K (1989) On the sequence of age at peak velocity individually in height and weight. *Anthropological Science*, 97, 189-199.
- Fujii, K. and Kawanami, K (1998b) An analysis in regard to relationship between age at MPV of height and weight, and its sex difference. *Japanese Journal of School Health*, 40, 317-331.