学 位 論 文 の 要 旨

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学位論文名　A New Program for Determining Abnormal Growth Curves in School Health Checkups
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論 文 内 容 の 要 旨

INTRODUCTION

Growth curves are essential tools for assessing physical and mental abnormalities in children. In Japan, the School Health and Safety Act of 1958 mandates annual health examinations for students, and since 2016, height and weight growth curves have been actively used in school health checkups following a directive from the Ministry of Education, Culture, Sports, Science and Technology. However, creating and interpreting growth curves requires significant time and expertise, making it difficult for school health educators and physicians to assess them accurately. To support schools, the Japan School Health Association introduced the "Children's Health Management Program (V4)" in 2015, which includes a growth curve assessment tool. V4 is designed to evaluate height, weight, and obesity trends from infancy to university age. It offers both group-based and individualized assessment features, but it can only evaluate data from a single academic year. Longitudinal assessments require manual data transfer using a designated Excel file, and abnormality detection involves multiple steps, making the process time-consuming and labor-intensive. In cities like Matsue and Izumo in Shimane Prefecture, evaluation committees composed of pediatric endocrinologists, school physicians, and family doctors review cases flagged by V4. However, past experiences show that approximately 70% of cases identified as abnormal by V4 were actually normal, placing a heavy burden on school staff and committees. Therefore, this study aimed to develop and validate a custom-designed program — Growth Assessment Program for Schools (GAPS) — that enables rapid and accurate detection of growth abnormalities in children and adolescents. The study compared the diagnostic performance of GAPS with V4 using 2021 school health checkup data from Izumo City.

MATERIALS AND METHODS

The researchers developed GAPS using Visual Basic for Applications in Microsoft Excel, based on the 2010 edition of Japanese growth curves. GAPS automates the detection of tall stature, short stature, obesity, weight gain/loss, abnormal growth rate, and precocious puberty using criteria defined by The Japan Endocrine Society in 2018. For precocious puberty, the program flags cases with a height velocity increase of ≥ 2 SD, while cases with ≥ 1 SD are also reviewed due to potential early-onset puberty. To avoid misinterpretation of normal pubertal growth as abnormal, GAPS restricts abnormal growth rate detection to boys aged ≤ 12 years and girls aged ≤ 10 years. The program also includes automated detection of abnormal weight changes using the percentage of overweight. Future versions may incorporate visual weight curve generation to enhance usability. The study analyzed data from 12,573 students (ages 6–15) from 46 schools in Izumo City, excluding 1,977 students due to inconsistent measurement dates. The 2021 school health checkup data (IZUMO21) included evaluations by the Izumo City Evaluation Committee, which categorized cases into five levels: (1) No abnormalities, (2) Follow-up observation at school, (3) Continued visits to family physician, (4) Continued treatment at current medical facility, and (5) Suspected condition requiring detailed examination. GAPS was applied to all IZUMO21 data. Cases flagged by GAPS but not reviewed by the committee were independently evaluated by two pediatric endocrinologists. Only cases where both agreed were considered abnormal. Categories included clear precocious puberty, suspected precocious puberty, abnormal growth rate decline, short stature, and tall stature. Diagnostic accuracy metrics—sensitivity, specificity, positive predictive value, negative predictive value, false positive rate, and false negative rate —were calculated for both GAPS and V4. The study protocol was approved by the Research Ethics Committee of Shimane University.

RESULTS AND DISCUSSION

GAPS offers a streamlined evaluation process: users input basic data and generate growth curves with a single click. This allows school staff to assess students' health conditions in real time. When applied to IZUMO21 data, GAPS identified nearly all students requiring detailed examinations (80 out of 81) and reduced the number of cases previously deemed abnormal by V4 from 1,321 to 403, suggesting improved specificity. Among 286 cases requiring school-level follow-up, GAPS flagged 146 as abnormal. The remaining cases were confirmed to be within normal range. Regarding the growth curves of students visiting family physicians or currently receiving treatment, the GAPS's identifications were almost perfectly consistent with the

determinations made by V4. Importantly, GAPS identified 2,824 abnormal cases among the 10,703 students not reviewed by the committee. Of these, 341 (2.9%) were previously missed cases of precocious puberty. Overall, 3.5% of students were flagged as potentially abnormal. Two pediatric endocrinologists reviewed these cases, and only those with consensus were considered abnormal. In terms of diagnostic accuracy, GAPS demonstrated a sensitivity of 0.99, specificity of 0.76, PPV of 0.16, and NPV of 0.99. In contrast, V4 showed a sensitivity of 0.24, specificity of 0.89, PPV of 0.09, and NPV of 0.96. GAPS had a significantly lower false negative rate (0.002 vs. 0.76), though its false positive rate was higher (0.24 vs. 0.11). These results suggest that GAPS is more effective in detecting true abnormalities, especially precocious puberty. The improved sensitivity of GAPS is attributed to its ability to detect height velocity changes at any point within the past year, unlike V4, which relies on single-point measurements. However, this also increases the false positive rate. To address this, future versions need to shorten the evaluation window to six months and lower age thresholds by one year. GAPS differs from V4 in its simplicity and immediacy. It allows continuous data input and instant updates, making it highly useful for school nurses. Growth curves can be saved and accessed anytime, and notes can be freely recorded. Long-term use might enhance the skills of health educators and foster collaboration between medical and educational professionals. Although developed in Izumo City, GAPS was designed for flexibility and could be applied in other regions. With appropriate training, its use is likely to extend beyond Shimane Prefecture. The system architecture also allows for adaptation using growth reference data from other populations, making it potentially applicable to children of various ethnic backgrounds. Limitations include reliance on Japanese growth data from 2000 and 2010, inability to account for measurement errors, and lack of clinical or laboratory data for diagnosing precocious puberty. These factors should be considered when interpreting the results.

CONCLUSION

The study successfully developed and validated GAPS, a new program for detecting abnormal growth curves in Japanese school health settings. GAPS is simpler and more accurate than existing tools like V4, particularly in identifying precocious puberty. While the program shows promise, further refinement is needed to reduce the false positive rate and ensure no cases requiring medical attention are missed. The authors will continue to refine and validate GAPS toward wider implementation across Shimane Prefecture.