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Original Article

Development of Height estimation formula in Elderly Adults Using Ambulatory Rehabilitation

AKIHIRO YAKABI RPT,PhD [1)], YOHEI SAWAYA RPT,MS[1, 2)], TAMAE SATO RPT,MS [1,2)]
MINAMI SATO RPT [2, 3)], AKIRA KUBO RPT,PhD [1)], MASAHIRO ISHIZAKA RPT,PhD [1)]
KO ONODA RPT,PhD [1)], TSUYOSHI HARA RPT,PhD [1)]

1) Department of Physical Therapy, school of Health Science, International University of Health and Welfare (2600-1 Kitakanemaru, Otawara-shi, Tochigi 324-8501, Japan)
2) Department of Physical Therapy, Graduate School of Health and Welfare Sciences, International University of Health and Welfare
3) Division of Rehabilitation Shioya Hospital of International University of Health and Welfare

Abstract. [Purpose] To develop a height estimation equation in addition to kyphosis index and forearm length and lower leg length. [Subjects and Methods] The estimated height of 122 elderly patients requiring long-term care who were unable to measure height while standing was estimated and calculated among the patients in the rehabilitation community, measured height, forearm length, lower leg length, and kyphosis index. [Results] The actual measured height in males and females was= 15.2 + (2.5 × lower leg length) + (2.5 × forearm length) + (- 0.6 × kyphosis index), and R^2 was 0.77 and improved more than the predicted form from the lower leg and forearm lengths.
[Conclusion] The accuracy is improved in the estimated height expression obtained by adding the kyphosis index to the independent variable for the lower leg and forearm lengths.
Key Words: Estimated equation, Kyphosis, Elderly people who need long-term care

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1. INTRODUCTION

"Height" is the length measured from the sole to the top of the head, generally in the upright position. It is used to assess a child's development and create prosthesis for leg amputee [1)]. Moreover, height measurement is necessary to assess the body composition component, body mass index (BMI), nutritional status, and basal metabolism, among others. In general, height is measured while standing with bare feet on the foot shaped as the plate of the height meter, standing on the post with the back part, buttocks, and heels in the posture with the jaws attached to the post with the outer ear hole of the head and the orbit the edge. As a precaution, when not standing, it is measured with the tape measure in the supine position[1)]. Previous studies has been reported that accurate height measurement is difficult in elderly people due to difficulty of maintaining a standing posture because of marked joint contracture, deformation, decreased ADL, etc. Nishida et al. reported that, the correlation coefficient of the height prediction formula is high (0.92), in the healthy adults, using the forearm and lower leg lengths[2)]. In addition, Kubo et al. calculated the estimated height according to the length of the forearm and lower of hospitalized elderly patients, and good correlation coefficient was obtained[3)]. However, when the estimated height formula was used at the clinical setting, the measured height was significantly different from the estimated height. This may be due to the great influence of joint contracture and deformity in

*Corresponding author: AKIHIRO YAKABI (yakabi@iuhw.ac.jp)

the spinal column, and in particular, spinal kyphosis influences the accuracy of the estimated height and is reported to most frequently change in elderly people's posture[4,5].Various factors such as gender, reduced muscle strength due to vertebral body deformation, limitation of trunk extension range of motion, agriculture-related word, and the living environment have been known to influence kyphosis[6]. In addition, "Height" of the declaration of the elderly is often inaccurate. Therefore, For measurement of accurate BMI and accurate body composition, it is necessary to have an estimated height formula that takes into account the kyphosis. Based on the prediction formula of a previous research, this study aimed to develop a regression equation considering the kyphosis and improve its accuracy. Temporarily, kyphosis is thought to have various effects on the predicted height. Therefore, we hypothesized that accuracy can be improved by inputting the kyphosis index into the prediction formula.

2. SUBJECTS AND METHODS

A total of 126 participants of Nishinasuno General Home Care Center were selected. Among them, the height of 122 elderly people can be measured in the standing position (consisting of 66 males and 56 females, with the following mean ± standard deviation: age, 77.3 ± 8.8 years, height, 153.1 ± 10.8 cm; body weight, 55.5 ± 12.0 kg; BMI, 22.2 ± 4.0 kg / m^2). The breakdown of Long-Term care/ Support Need level is as follows: 20 persons in requiring support 1, 16 persons in requiring support 2, 41 persons in requiring long-term care 1, 28 persons in requiring long-term care 2, 11 persons in requiring long-term care 3, 8 persons in requiring long-term care 4, and 2 persons in requiring long-term care 5. Before the measurement, the purpose and method of study were explained, and consent of participation was obtained. In addition, consent of Nishinasuno General Home Care Center was obtain.

This study was approved (approval number: 17 - Io - 189) by the Research Ethics Review Committee of the International University of Health and Welfare.

Forearm length, lower leg length, and kyphosis index were measured in all patients. Limb length was measured by major meter in sitting position. Forearm length was measured from the proximal olecranon to distal ulna shaped projection in 90° elbow joint flexural rank. Lower leg length was measured from the proximal head of fibula to the distal lateral malleolus. The kyphosis index[7] was calculated from measurements obtained using a flexible curve ruler, a pliable instrument molded to the spinal curvature from C7 to L4 with the patient in sitting position. The molded-flexible curve was then traced to reflect thoracic and lumbar spinal curvatures. From the tracings, the kyphosis index for the thoracic spine was determined, its validity and reliability were also considered[8-10].

In the statistical analysis, a stepwise method was performed using a multiple regression analysis with the measured height as the dependent variable and the forearm length, lower legs length, and kyphosis index as independent variables. In addition, Pearson's correlation coefficient was calculated to clarify the relationship between measured height and the forearm length, lower legs length, and kyphosis index. For all statistical analyses, the SPSS Statistics version 22 (manufactured by IBM) was used and the significance level was set at 5%.

3. RESULTS

The mean and standard deviation of each height measurement (Table 1) were as follows: height of 153.1 ± 10.8cm, forearm length of 24.0 ± 1.7cm, lower leg length of 33.4 ± 2.3cm, and kyphosis index of 10.8 ± 3.3. Correlation coefficients with actual measured height were forearm length of 0.81, lower leg length of 0.83, and kyphosis index of -0.01. The regression equation in elderly people obtained using the multiple regression analysis (Table 2) is the total measured height = 15.2 + (2.5 × lower leg length) + (2.5 × forearm length) + (- 0.6 × kyphosis index). The adjusted determination coefficient (hereinafter referred to as adjusted R^2) was 0.77. Males' actual measured height = 65.4 + (2.9 ×lower leg length) + (-0.7 ×kyphosis index), with the adjusted R^2 of 0.68. Female's' measured height = 15.5 + (2.9 × lower leg length) + (-0.6 ×kyphosis index) + (1.9 × forearm length), with the adjusted R^2 of 0.56.

Table 1 Relationship between measured height and forearm length, lower leg length, kyphosis index

	total(n = 122)		male(n = 66)		female(n = 56)	
	Mean±SD	Correlation coefficients	Mean±SD	Correlation coefficients	Mean±SD	Correlation coefficients
height(cm)	153.1±10.8	—	159.7±7.4	—	145.3±8.8	—
forearm length(cm)	24.0±1.7	0.81*	25.2±1.2	0.65*	22.8±1.1	0.60*
lower leg length(cm)	33.4±2.3	0.83*	34.6±2.1	0.76*	31.9±1.5	0.69*
kyphosis index	10.8±3.3	-0.01	11.2±3.5	-0.18	10.2±3.1	-0.33*

* : $p<0.05$　Mean±SD: Mean value ± Standard deviation

・Forearm length: measured from the proximal olecranon to distal ulna shaped projection in 90° elbow joint flexural rank.

・Lower leg length: measured from the proximal head of fibula to the distal lateral malleolus.

・The kyphosis index: calculated from measurements obtained using a flexible curve ruler, a pliable instrument molded to the spinal curvature from C7 to L4 with the patient in sitting position. The molded-flexible curve was then traced to reflect thoracic and lumbar spinal curvatures.

Table 2　Regression equation and Correlation coefficients of height

		Correlation coefficients	the adjusted R^2	p value
total	height＝15.2＋(2.5×lower leg length)＋(2.5×forearm length)＋(-0.6×kyphosis index)	r＝0.87	R^2＝0.77	p＜0.01
male	height＝65.4＋(2.9×lower leg length)＋(-0.7×kyphosis index)	r＝0.82	R^2＝0.68	p＜0.01
female	height＝15.5＋(2.9×lower leg length)＋(1.9×forearm length)＋(-0.6×kyphosis index)	r＝0.75	R^2＝0.56	p＜0.01

4. DISCUSSION

This study, with reference to the estimated height formulas in previous studies, focused on kyphosis, reported as most common in posture changes in elderly people. The degree of kyphosis has been thought to affect the estimated height. Therefore, the accuracy of the estimated height expression should be increased by performing multiple regression analysis including the kyphosis index as one of the independent variables. Nishida et al.[2)]and Kubo[3)] have measured the length of the forearm and lower legs without considering joint deformation. However, in these estimation formulas, the influence of kyphosis caused by age and joint deformation in the lower leg cannot be determined. Therefore, in addition to the forearm and lower leg length, used in previous studies, a regression equation that puts the kyphosis index as an independent variable was developed in this study. Using a multiple regression analysis (stepwise method) with the measured height as the dependent variable and the forearm length, lower leg length, and kyphosis index as independent variables, the prediction expression obtained is more accurate than the expression of forearm and lower leg length only. The regression equation of the forearm length + the lower leg length in the regression equation for males and females is adjusted R^2 = 0.73. The regression equation of the forearm length + lower leg length + kyphosis index was adjusted R^2 ＝0.77. The regression equation in males was regression formula of the lower leg length: adjusted R^2 =

0.58, and the accuracy was improved with R^2 = 0.68 in regression equation of lower leg + kyphosis index. The regression equation in females was regression formula of the lower leg length: adjusted R^2 = 0.47, regression equation of lower leg + forearm length + kyphosis index: adjusted R^2 = 0.56, which resulted in improved accuracy. This is based on the hypothesis that during height measurements in an upright posture in elderly people, the actual height was lower than the predicted height due to kyphosis; therefore, by inserting the kyphosis index as an independent variable, the precision of regression equation was considered to be improved.

However, in this study, 122 participants cannot be considered as a sufficient number of samples. Posture changes not only affect kyphosis but also influence joint deformation in the lower leg, which is sufficiently conceivable. And their malalignment at neck were not measured, orthopedic disease were not investigate (knee or hip osteoarthritis). Therefore, a similar study should be conducted with a large sample-sized cohort to expand the field, and a prediction formula that considers not only the influence of kyphosis but also hip and knee joints should be established. In addition, the ability of rapid measurement should be considered when using the prediction formula; therefore, instruments that can immediately calculate the extent of the spine should also be developed.

Funding and Conflict of interest

No funding was provided for this study. The author declares no conflict of interest.

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Original Article

Relationship between Students' preferences for Flipped or Traditional classrooms and Perceived course workload

MASAFUMI ITOKAZU,RPT, PhD[1)]

1) Department of Physical Therapy, school of Health Science at Narita, International University of Health and Welfare (4-3 Kōzunomori, Narita City, Chiba 286-8686, Japan)

Abstract. [Purpose] The purpose of this study was to investigate whether students preferred a flipped classroom to a traditional classroom teaching method and determine how students perceived their workload in flipped classrooms via quantitative evaluation. [Subjects and Methods] The participants were 153 students belonging to the Department of Physical Therapy. The questionnaire survey asking about their impressions of the course and the workload was given after the course. [Results] About 70% of the students who participated in the flipped classroom preferred it, while 15% preferred the traditional classroom. The workload for students in the flipped classroom was significantly higher than for those in the traditional classroom. [Conclusion] The results of the study suggested that there are a certain number of students who prefer TC, and it is necessary to give a thorough preliminary explanation of the flipped classroom methodology to make it successful.
Key Words: Flipped classroom, Traditional classroom, Course workload

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1. INTRODUCTION

In the current university education environment, active learning in classrooms is being frequently promoted[1,2)]. The flipped classroom (FC) is an active learning method[3,4)]. What differentiates it from the traditional classroom (TC) is that the students attend classes after watching a lecture video online, which provides them with basic knowledge of the topics that will be explored in the classroom[5,6)]. Students are then required to apply the basic knowledge learned from the video to group work in the classroom, and this promotes active learning[6)].

Many practical examples are reported in Japan and other countries[7-11)]. Two reported results of using FCs are that periodic testing results are significantly better in comparison with that of TCs, and the students' active learning ability is improved[7-10)]. What is common to the research is that although it takes time to introduce FCs, it is a better method for promoting student motivation for learning than TCs[9,13,14)]. There has been much research on the introduction of the FC in training courses for medical doctors, nurses, and rehabilitation specialists[12,14-19)] While many of them have found that the FC is more effective than the TC[4,8,11)], some studies have raised concerns about the increased workload for students inherent in the FC[15-21)]. Some previous studies have found student dissatisfaction increased after the introduction of the FC[15,18,21)]. However, these few studies use limited objective indicators such as learning time[4)], and it is difficult to indicate that they objectively evaluate the psychological students' workload participating in FC.

*Corresponding author: MASAFUMI ITOKAZU (itokazu@iuhw.ac.jp)

In this study, we hypothesized that the workload of FC adoption varies among students and that it is higher among students who prefer TC than among students who prefer FC. The purpose of this research was to investigate whether students preferred the FC to the TC and to determine via quantitative evaluation how students perceived their time and psychological workload in FCs.

2. SUBJECTS AND METHODS

The participants were second and third- year university physical therapy students (N = 153, male: 82, female: 71; age: 20.3 ± 2.3 years). The study was conducted by the Declaration of Helsinki. Participants were provided an information sheet on the study, and they gave written informed consent.

Students participated in and completed a course in which the FC methodology was used. After completing the course, the questionnaire survey asking about their impressions of course workload as compared to that of a TC was given.

The questionnaire investigated "ease of understanding" and "ease of learning," using a five-point Likert scale: 1: traditional; 2: likely traditional; 3: neither; 4: likely flipped: and 5: flipped. In addition, the participants' perception of the workload in an FC compared to what they perceived in a TC was investigated using a ten-point scale (from 1: not at all to 10: very much).

In the questionnaire results, the ratio of each stage of "easy to understand" and "easy to learn" was calculated. The median value and quartile range were calculated for the students' workload in the FC. Dependent on the answers to the questions, the participants were divided into three groups: Flipped group: group of flipped and likely flipped answered; Traditional group: group of traditional and likely traditional answered, and the course workload of each group was calculated. The Kruskal-Wallis test was performed on the data to determine statistically significant differences among the three groups. The Steel-Dwass test accounted for multiple comparisons within all groups. The relationship between the answers to the questions about the FC and the students' course workload was calculated using Spearman's correlation coefficient. Statistical analysis was conducted using R 2.8.1, and significance was assumed at $p<0.05$.

3. RESULTS

Table 1 shows the results of the questionnaire. The percentages for "ease of understanding" were flipped: 23.5%, likely flipped: 44.4%, neither: 18.3%, likely traditional: 5.2%, and traditional: 8.5%. The percentages for "ease of learning" were flipped: 26.1%, likely flipped: 39.9%, neither: 17.6%, likely traditional: 7.2%, and traditional: 9.2%.

Table 2 shows the students' workload as weightings that students assigned in point to "ease of understanding" and "ease of learning" in the FC as compared to the TC. The perceived workload of the group that preferred the TC was significantly higher than that which preferred the FC.

Table 1 Number and percentage of the answers to the questionnaire items

Number of students (percentage)	Flipped	Likely Flipped	Neither	Likely Traditional	Traditional
Ease of understanding	36 (23.5%)	68 (44.4%)	28 (18.3%)	8 (5.2%)	13 (8.5%)
Ease of learning	40 (26.1%)	61 (39.9%)	27 (17.6%)	11 (7.2%)	14 (9.2%)

n=153

Table 2 Comparison of students' perceived workload points in the FC compared to the TC

Workload, median (25%, 75%)	Flipped group	Neither	Traditional group
Ease of understanding	3 (2 - 5)	3 (2.5 - 6)	5 (3 - 6) *
Ease of learning	3 (2 - 5)	3.5 (3 - 5)	5 (3.75 - 6.25) *

*: $p<0.05$

Flipped group: group of flipped and likely flipped answered; Traditional group: group of traditional and likely traditional answered. Workload point: evaluated using a ten-point scale

4. DISCUSSION

The FC is one of the active learning methods that has attracted attention in recent years and is now being used in various educational fields[1,2]. It is being aggressively introduced to the field of medical education, and many of the previous studies report that the introduction of FC can encourage students in active study[6]. However, a feature of the FC is that students must watch the lecture video online in advance, which busy students may consider to be an increased course workload[15,18,21]. Therefore, the purpose of this study was to examine the preferences of students who participated in a FC and to use quantitative evaluation to determine the relationship between their preferences and the workload as perceived by them.

Although several studies have examined students' acceptance of the FC, most have shown that many students prefer the FC to the TC. The reason is that students prefer active tasks such as group work to desk work[2,4,11]. They also reported that students appreciate the characteristics of the FC: they gain basic knowledge by watching videos before classes, and they gain developmental knowledge in lectures[2,4,11]. Previous research has shown that 70 to 80% of students prefer FC[24-27]. Our study results were comparable as they showed that approximately 70% of the students had better understanding and ease of learning in the FC than when in traditional lecture classrooms. On the other hand, about 15% of our students favored traditional teaching styles over the flipped style. Previous studies have shown that the FC tends to be preferred by many students[24-27], but not by all, and this may be associated with personality type and motivation for learning[7-10]. The reasons why students may not prefer the FC are that it takes time to watch videos[24-27], they may not understand the purpose and theory behind the FC[24-27], and/or they do not like new learning methods and prefer sticking with traditional methods[7-10]. The characteristics of students who prefer TCs need to be investigated in more detail so that ways to support different types of students can be developed.

We evaluated the course workload as perceived by students in the FC. Previous studies have reported that by watching videos before classes, students' workloads would be increased as compared to the TC[15,21,24]. However, few studies have attempted to evaluate the students' workload quantitatively, and the relationship between the class style supported by the students and the students' workload had not been evaluated. Therefore, in this research, we evaluated the quantitative workload using the 10-point scale and examined the perceived differences in the students' workloads. In our results, students preferring the FC felt the FC course workload was 3 out of 10 points, and for students preferring the TC it was 5 out of 10 points. This result suggests that students who prefer the TC perceive a greater workload when in the FC course.

The results of this study show that a certain number of students prefer TC, and as described in previous studies, it is necessary to give them a sufficient explanation of the purpose and methods used in FCs[28]. It is also important to check whether students can adapt to the class style once the FC is introduced by checking lecture video viewing logs and observing the students in the FC environment.

The limitation of this study was that we did not get data on students' perception of the workload at the time they were introduced to the FC. When we have this data, it can be possible to institute additional measures to help students. Also, no specific support measures have yet been considered for students who prefer the TC. The FC environment makes it easier to help individual students with problems than the TC, and when problems are identified, it will be easier to provide support in the FC.

Funding and Conflict of interest

No funding was provided for this study. The author declares no conflict of interest.

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