Preventive Care in Nursing and Midwifery Journal
2022; 12(4): 26-34

Fetal Development Assessment Information Scale (FDAIS): Development and Initial Validation

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Received: 30 Jan 2022 **Accepted**: 22 Sep 2022

Abstract

Background: Teaching and evaluating fetal development are essential for evaluating maternal and fetal health in the midwifery profession.
Objectives: The present study was carried out to examine the validity and reliability of the fetal Development Assessment Information Scale (FDAIS).
Methods: The study data were collected online between March 25 and May 15, 2021, via social media accounts of midwifery students with convenience sampling. 410 midwifery students were included in the study. The data were analyzed using SPSS- AMOS software version 20, descriptive statistics (mean, standard deviation, frequency, and frequency percentage), Exploratory Factor Analysis (EFA), and Confirmatory Factor Analysis (CFA). The suitability of the data for factor analysis was investigated by the Kaiser-Meyer-Olkin coefficient and by Barlett's test of sphericity.
***Results*:** The content validity index of the draft scale was 87%. Kaiser Meyer Olkin test value was 0.927, and the sample was found to be adequate and appropriate. On the other hand, the Bartlett test was obtained as $\chi 2(253) = 2648{,}074$ $p<0.001$, and it was accepted that the scale fulfilled the requirements for exploratory factor analysis. The scale took its final form and consisted of 23 items and one dimension due to the exploratory factor analysis and confirmatory factor analysis. The total percentage of variance explained was 36,50%. The Cronbach's alpha coefficient of the scale was 0.89 high. According to the results of the CFA analysis, when the FDAIS goodness-of-fit indexes are examined; RMSEA 0.046; While it shows acceptable agreement with $\chi 2$; GFI 0.916; CFI 0.918; It was found that it was in perfect agreement with ($p=0.000$).
Conclusion: According to the findings, the Fetal Development Assessment Information Scale (FDAIS) is a valid and reliable measurement tool for undergraduate midwifery students in Turkey and can be used in studies.

Keywords: fetal development assessment scale, validity, reliability, midwifery education

Introduction

Human development is a cycle that includes successive developmental processes [1]. This cycle begins with the fertilization of the sperm, which is the male gamete, and the ovum, which is the female gamete [1]. The zygote, which carries all the genes of human development due to fertilization, is the beginning of all unique formations. The zygote divides, differentiates, grows, and transforms from a single cell to a multicellular human structure [1]. In embryonic development, the fetus and its appendages develop with these divisions. The healthy continuation of the process is possible if both the

fetus and the placenta continue in their normal developmental process. The fetal development process consists of three stages. The first stage is the pre-embryonic period from fertilization to the second week; the second stage is embryonic development between the fifteenth day and the eighth week after fertilization [1]. Fetal or non-embryonic developments appear during this period. The final stage is the fetal period from the end of the eighth week of pregnancy to birth. It is essential to perceive normal growth, development, and maturation at all these stages in detecting maternal and fetal complications. Considering that vaginal birth and risky birth training are given after the pregnancy, and fetal development processes are taught, it is understood that these subjects should be well understood and learned. Thus, teaching methods of fetal development in the education system are developing day by day. These methods can be listed as simulation training, virtual reality, 3D imaging, or video-assisted training. Nowadays, simulation education is increasing, and it is used effectively in many fields of midwifery education [2]. It is observed that simulation training in midwifery is used more during pregnancy, birth, or postpartum [3,4]. Teaching pregnancy, which is the basis of midwifery education, with different educational techniques and minimizing clinical practice errors is essential in providing early diagnosis of fetal presentation and placental anomalies during pregnancy and birth. Students get the opportunity to effectively observe the differences and maternal-fetal response in the following weeks of pregnancy with virtual reality applications. Virtual pregnancy application is a current and vital issue that allows students to see the pregnancy process, maternal-fetal development, placental differences, and the mother's circulatory response in a three-dimensional way without any hindrance [4–8]. Evaluating and measuring the effectiveness of fetal development training methods used for students is of great importance in monitoring and evaluating fetal health. When the literature was examined, no tool was found to measure this effectiveness. The current study aims to develop the Fetal Development Assessment Information Scale (FDAIS) that can measure the knowledge level of midwifery students who take any course in which fetal development is explained.

Methods

Study design

The present study is a methodological study conducted to develop a valid and reliable measurement tool that can objectively evaluate fetal development information of midwifery students week by week. Research data were collected online between March 25 and May 15, 2021.

Population and Sample of the Research

The research population consisted of second, third, and fourth-year undergraduate students who continue to study in the midwifery departments of 57 universities in Turkey and take a course on fetal development. All students enrolled in the midwifery programs of these universities were invited to participate in the current study through convenience sampling and social media accounts of midwifery students. The data were collected from students who agreed to participate in the study through a questionnaire prepared in Google Forms.

The literature reports that the sample should be 5 to 10 times scale items in scale development studies [9]. It is stated that the sample size in scale development studies would be very weak; 100, weak; 200, unstable; 300, good; 500, very good; and 1000 and above, ideal [10] . Based on this information, the present study sample consisted of 410 students who met the inclusion criteria. There are 82 statements in the draft scale, whose validity and reliability study is planned.

Data Collection Tools

In the present study, the data were collected with the Socio-Demographic Characteristics Identification Form to evaluate the participants' characteristics and the fetal development assessment information scale, which the researcher prepared by scanning the relevant literature and arranging with the opinion of 14 experts.

Socio-Demographic Characteristics Diagnosis Form

The form consists of four items, including questions about the participants' age, grade, region of residence, and whether they have taken a course on fetal development before, in line with the literature.

Fetal development assessment information scale (FDAIS)

Determining the Purpose of the Scale: According to the latest literature information and the midwifery core curriculum created by the Council of Higher Education (CoHE), it was aimed to determine the respondents correct, incomplete or incorrect information about fetal development.

Establishing the Item Pool

The researchers created 82 in Turkish language questions in line with the literature containing information about fetal development and following the rules to be considered in writing the statements. After the item pool was created, the expressions were checked in terms of formal and grammatical knowledge.

Submitting the Item Pool for Expert Opinion

An item pool was created and presented to the expert opinion to review the scale to find evidence for the content validity. Experts were asked to evaluate whether each item related to the expressions measures the structure to be measured, whether it is scientifically correct, whether there are grammatical and spelling errors, and whether it is suitable for the developmental characteristics of the respondents. As a result, feedback was received from fourteen experts with an expert evaluation form. Content Validity Ratio (CVR) and Content Validity Index (CVI) for the entire test were calculated to exclude items from the scale.

Statistical analysis

Content Validity Index (CVI)

Eighty-two items created by the researchers in line with the literature were first presented to fourteen experts. After the expert opinion of the 82-item scale, which was submitted to the opinion of fourteen experts, the Content Validity Index of the scale was calculated in Microsoft Excel software.

Construct Validity

Exploratory factor analysis

Exploratory factor analysis was performed to identify the factor structure of the PCSMN [11] using SPSS 20.0 (SPSS Inc., Chicago, IL, USA). Principal component analysis and varimax rotation were used in exploratory factor analysis. The eigenvalue of factors, the scree plot, the percentage of variance explained, and factor loading of items were combined to identify the factor structure of the FDAIS. Eigenvalues ≥ 1.0, and factor loading values ≥ 0.5, were considered as the criteria [12]. In addition, the Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity were also carried out, and a KMO coefficient more than 0.8 was considered significant. The suitability of the data for factor analysis was examined using the Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity. The reliability of the scale was examined with Cronbach's alpha [13].

Composite reliability (Composite Reliability-CR) and average explained variance (Average Variance Extracted-AVE) values were calculated for the total convergent and divergent validity of the scale. CR value of 0.70 and above and AVE values of 0.50 and above indicate convergent validity. For divergent validity, correlations between variables were calculated and the square root of AVE values should be greater than these correlation values. For this reason, it was determined that the conditions were met according to the results (AVE= 0,327; CR=0,915; $\sqrt{}$AVE= 0,57246739).

Confirmatory factor analysis

Confirmatory factor analysis was performed to validate the factor structure of the PCSMN developed in exploratory factor analysis using AMOS 26.0 (IBM Corp., Armonk, NY, USA). Covariance matrices and the maximum likelihood estimations were used in the confirmatory factor analysis. The acceptable model fit was determined by the following criteria: $\chi 2/df \leq 1.869$, RMSEA < 0.046, NFI > 0.90, IFI > 0.90, TLI > 0.91, CFI > 0.92.

The data obtained in the present study were analyzed using the SPSS (Statistical Package for the Social Sciences) 20.0 software. Descriptive statistical methods (number, percentage, mean, standard deviation) were used while evaluating the data. Since the Skewness and Kurtosis values of the data were within the range of +2.0/-2.0, it was accepted that the data showed a normal distribution [14].

Results

Characteristics of participants

The mean age of the students participating in the current study was 21.13±1.60. It was found that 43.2% of the participants were in the third grade, 39.5% in the second grade, and 17.3% in the fourth grade. 29% of the schools where students receive education are in the Marmara region, 22.7% in the Central Anatolia Region, 19.8% in

the Black Sea Region, 11.5% in the Eastern Anatolia Region, 8.8% in the Mediterranean Region, 5.4% in the Aegean Region, and 2.9% are in the Southeastern Anatolia Region. Examining the participants' previous knowledge of fetal development or taking a course, it was observed that 97.8% of them took courses or training, and 2.2% did not receive any course or training (Table 1). The distribution regarding the demographic characteristics of the participants is given in Table 1.

Table 1: Demographic Characteristics of the Participants (N=410)

Demographic Characteristics		n
Students' Grade Level	2nd Grade	162 (39.5%)
	3rd Grade	177 (43.2%)
	4th Grade	71 (17.3%)
Regions Where Students' Universities Are Located	Marmara Region	119 (29%)
	Central Anatolia Region	93 (22.7%)
	Black Sea Region	81 (19.8%)
	Eastern Anatolia Region	47 (11.5%)
	the Mediterranean region	36 (8.8%)
	Aegean Region	22 (5.4%)
	Southeast Anatolia Region	12 (2.9%)
Students' Taking Course Status in Fetal Development	Yes	401 (97.8%)
	No	9 (2.2%)

Validity Analysis

Content Validity Index of the scale was 0.87 after the expert opinion of the 82-item scale was submitted to the opinion of fourteen experts. Since this value is higher than the accepted criterion of 0.80, it was concluded that the content validity was appropriate [9].

It was determined that Fetal Development Assessment Information Scale was unidimensional. In this context, explanatory factor analysis was carried out to reveal the factor design of the instrument (Table 2).

The Kaiser-Meyer-Olkin (KMO) test was applied before the exploratory factor analysis to test the suitability of the sample size for factorization. As a result of the analysis, it was discovered that the KMO value was 0.927. In the light of this finding, it was concluded that the sample size was "marvelous" for factor analysis. In addition, when the results of the Bartlett sphericity test were examined, it was seen that the obtained chi-square value was significant.

Exploratory factor analysis

Explanatory factor analysis was performed using the Principal Components Analysis and Promax Rotation methods to examine the scale's factor structure after confirming the suitability of the data for factor analysis.

The exploratory factor analysis excluded items 2, 4, and 5 with anti-image correlation values below 0.5. As a result of the analysis, it was determined that only one item was loaded on other factors than it was in the factor design of the original scale (1, 6, 8, 9, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 36, 40, 41, 43, 44, 45, 46, 49, 51, 52, 53, Articles 55, 57, 59, 61, 63, 64, 66, 67, 68, 69, 71, 73, 74, 75, 76, 77, 78, 80 and 82 were omitted). After these items were excluded from the analysis, factor analysis was performed again. When the resulting pattern was examined, the remaining items consisted of a single factor design. The contribution of these components to the total variance was 36%. In the explanatory factor analysis performed to reveal the factor pattern of the scale, the acceptance level for factor loading values was determined as 0.300 (Table 2).

Table 2: Explanatory Factor Analysis and Reliability Results of the Fetal Development Evaluation Information Scale

Items	Explained Variance (%)	Eigenvalue	Factor Load	Average	SS
Item 1	36.50	2.131	0.527	0.95	0.210
Item 2			0.573	0.86	0.346
Item 3			0.355	0.73	0.442
Item 4			0.489	0.90	0.304
Item 5			0.557	0.89	0.310
Item 6			0.640	0.76	0.430
Item 7			0.530	0.84	0.368
Item 8			0.469	0.85	0.359
Item 9			0.421	0.83	0.377
Item 10			0.565	0.79	0.409
Item 11			0.734	0.64	0.482
Item 12			0.591	0.83	0.379
Item 13			0.604	0.71	0.456
Item 14			0.539	0.72	0.449
Item 15			0.367	0.82	0.381
Item 16			0.518	0.81	0.389
Item 17			0.731	0.71	0.456
Item 18			0.681	0.70	0.460
Item 19			0.679	0.61	0.487
Item 20			0.626	0.71	0.454
Item 21			0.684	0.74	0.438
Item 22			0.633	0.73	0.446
Item 23			0.428	0.91	0.280
Toplam(α=0.89)					
KMO =0.927; $\chi 2(410)$ =2648.074; Bartlett's test of sphericity (p) = 0.000					

Confirmatory factor analysis, convergent validity and discriminant validity

According to confirmatory factor analysis, structural equation modeling results of the scale were significant at the p=0.000 level; it was determined that it was related to the 23 items that make up the scale and the single-factor scale structure (Table 3). The model has been improved; a covariance was created between errors with high MI values during the improvement. According to the results of the first level multi-factor analysis, when the goodness of fit indices of the Fetal Development Evaluation Information Scale was examined, it was found that while the RMSEA was in acceptable agreement with 0.046, the $\chi 2$ was in excellent agreement with the GFI 0.916 and CFI 0.918 (p=0.000) (Table 4) (Figure 1).

Table 3: Item analysis Results for the Items of Fetal Development Assessment Information Scale

Scale items		Item Total Score Correlation	t (Under % 27**-Upper %27**)	p value (Under % 27**-Upper %27**)	Cronbach Alpha Coefficient
1	The chromosomes of the sperm and ovum, reduced to half due to meiosis, fertilize to form a new cell with 46 chromosomes, the "zygote."	.155	3.653	0.000***	.894
2	The two daughter cells formed as a result of the first mitosis division are called blastomeric.	.234	6.247	0.000 ***	.894
3	The formation which is 1-2 weeks after fertilization is called blastocyst.	.384	10.827	0.000***	.891
4	The outer layer of trophoblasts is the syncytiotrophoblast.	.240	5.368	0.000***	.894
5	The embryonic stage is also called the organogenesis stage.	.243	5.368	0.000***	.894
6	The third germ leaf is formed in the third week of pregnancy.	.611	14.087	0.000***	.885
7	Blood circulation between the chorionic villi and the embryo begins on the 24th day.	.437	8.851	0.000***	.890
8	The brain is formed from the embryo's anterior end, and the spinal cord is formed from the embryo's posterior end.	.423	8.851	0.000***	.890
9	At the end of the 5th week, external genitalia, primitive arms and legs, eyes, nose, and ears appear.	.474	10.252	0.000***	.889
10	Neural tube, brain and spinal cord tissue develops at 6 weeks.	.480	10.632	0.000***	.889
11	Tongue and lip formation in the embryo is completed in the 8th week.	.643	25.306	0.000***	.884
12	Although the fingers and toes are formed in the embryo at the 8th week, they are connected by webs.	.516	10.252	0.000***	.888
13	Umbilical cord begins to form in the 3rd and 4th weeks.	.534	15.609	0.000***	.887
14	The umbilical cord develops at the end of the 12th week.	.566	13.811	0.000***	.886
15	Wharton's jelly surrounds the arteries and vein in the umbilical cord.	.378	8.205	0.000***	.891
16	The fetus begins to urinate into the amniotic fluid after the 12th week.	.571	11.649	0.000***	.887
17	The development of the intestines begins to develop in the 13th week.	.680	22.147	0.000***	.883
18	The swallowing, yawning and grimacing movements of the fetus begin at the 14th week.	.587	16,300	0.000***	.886
19	The first stool of the fetus, called meconium, begins to form in the 18th week.	.639	20.305	0.000***	.884
20	Male fetus testicles begin to descend into the scrotum at 22 weeks.	.558	14.968	0.000***	.887
21	The fetus begins to respond consciously to stimuli at 24 weeks.	.613	15.609	0.000***	.885
22	The fetus makes a stiff catch reflex within 38 weeks..	.635	17.409	0.000***	.884
23	The fetus can now adapt to the environmental factors between 36 and 40 weeks.	.306	5.220	0.000***	.892

* n = 410, ** $n_1 = n_2$ 110,
*** Significant values for $p < 0.05$.

Table 4: Fetal Development Assessment Information Scale: First Level Multifactor Model Confirmatory Factor Analysis Fit Indices

Goodness of Fit Measures	Perfect Fit Criteria	Acceptable Fit Criteria	Pre-Modification	Post Modification
CMIN/Df	$0 \leq \chi^2/df \leq 3$	$3 \leq \chi^2/df \leq 5$	3.042	1.869
GFI	0.90≤GFI	0.80≤GFI	0.587	0.916
AGFI	0.90≤AGFI	0.80≤AGFI	0.566	0.899
CFI	0.95≤CFI	0.85≤CFI	0.535	0.918
RMSEA	0.0≤RMSEA≤0.05	0.06≤RMSEA≤1.0	0.071	0.046
NFI	0.95≤NFI	0.80≤NFI	0.439	0.899
TLI	0.90≤TLI	0.80≤TLI	0.523	0.910
IFI	0.95≤IFI	0.85≤IFI	0.538	0.919

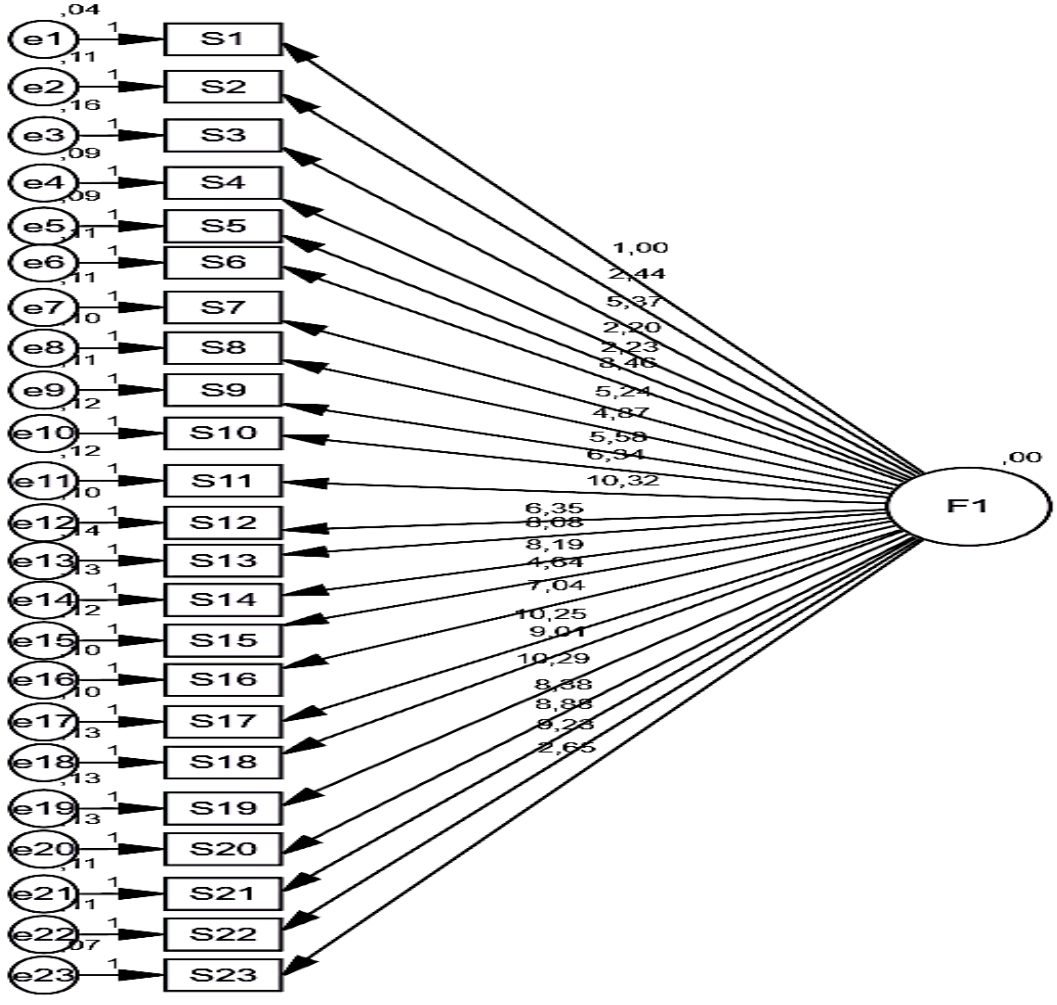

Figure 1: Fetal Development Assessment Information Scale Path Diagram and Standardized Regression Coefficients (The letter "S" stands for Item).

Table 3 shows the independent group t-test results showing the discrimination power of all items and item-total correlation. The item-total test correlation values of all items vary between 0.155 and 0.680. As seen in the item-total test correlation table, it was found that all the

remaining items were related to each other. The raw scores obtained from the scale were ordered from largest to smallest, and the mean scores of the groups in the lower 27% and upper 27% were compared with the independent group t-test to determine the distinctiveness of the items in the scale. As a result of the comparison, it was seen that there was a statistically significant difference between the averages of the lower and upper group item scores. From this point of view, it can be said that the scale is distinctive in terms of measuring the desired quality. The item with a correlation coefficient of 0.155 had to be removed from the scale. However, it was decided not to remove the item from the scale since it did not affect EFA and CFA. The item had to be included in the scale, the Cronbach Alpha value was high, and it was significant in the t-test.

Reliability Analysis

The Cronbach Alpha value was calculated as 0.89 overall (Table 3). According to Nuran Bayram, a Cronbach Alpha value above 0.70 is sufficient for reliability. In this case, the reliability of the adapted scale was high [15].

The scale is a knowledge scale consisting of 23 questions with options such as east, wrong and I don't know. While calculating the scale scores, items with correct answers will receive 1 (one) point, and items with incorrect and don't know answers will receive 0 (zero) points. There is no reverse item in the scale. The highest total score to be obtained from the scale is 23 (twenty-three), and the lowest score is 0 (zero).

Discussion

The current study aims to develop the fetal development assessment information scale (FDAIS). The most frequently used method for the construct validity of the measurement tool is factor analysis [16]. Before these analyzes, KMO and Bartlett's Sphericitiy tests were performed to evaluate the suitability of the required data for factor analysis and sample size [16–18]. In line with this purpose, EFA and CFA were conducted for validity and reliability. As a result of the analysis, KMO=0.927 and Bartlett's Sphericitiy test were found significant ($\chi 2(253) = 2648.074$, $p = 0.000$). KMO value was greater than 0.60, and Barlett's Sphericity test less than $p<0.05$; it indicates that the tests were meaningful and the data obtained were suitable for factor analysis.

The Cronbach's alpha coefficient of the fetal development assessment information scale (FDAIS) was highly reliable. The study's strengths are that the sample size is in the range considered "good", and the Cronbach alpha reliability coefficient is high.

A review of the texts showed that a few materials have been developed for the teaching of fetal development, but there is no measurement tool to measure the effectiveness of these materials [12-19]. This result showed that the FDAIS scale developed in our study is a new measurement tool in the literature and is an up-to-date scale.

Limitations

There are two limitations for this study. The first is that it covers midwifery students. Secondly, since there is no scale measuring fetal development knowledge level in the literature and Turkish, its concurrent validity could not be tested.

Conclusion

As a result of the statistical evaluations for validity and reliability, it was found that the FDAIS scale is a valid and reliable measurement tool to determine the knowledge level of midwifery students about fetal development. It has been concluded that the scale can be applied to all midwifery students who take fetal development courses and can be used in studies. The scale includes a total of 23 items and a single sub-dimension. The answers to the scale consist of three sets of items: "true", "false", and "I do not know". Among the "True/False/I do not know" answer type questions, 1 point is given to those who answer correctly, and 0 points are given to those who do not know and give wrong answers. The maximum score obtained from the scale is 23, and the minimum score is 0. It is concluded that as the score obtained from the scale increases, the level of knowledge about fetal development also increases.

Acknowledgments

Ethical compliance approval was obtained from the Health Sciences University, Hamidiye Scientific Research Ethics Committee (Date: 26.02.2021 Decision No: 21/196) before the data were collected.

Conflict of interest
This way is appropriate. It can stay that way.

Funding:
This article has not received funding from any institution.

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