



Research Article

A study on the development of the validated *Asthi Sara* Assessment Inventory (ASAI)

Praveen Kumar Singh¹, Vandana Verma^{2*}, Girish Singh³

1. Junior Resident-3, Department of Kriya Sharir, Faculty of Ayurveda, IMS, BHU, Varanasi 221 005. India.

2. Assistant Professor, Department of Kriya Sharir, Faculty of Ayurveda, IMS, BHU, Varanasi. 221 005. India.

3. Professor, Division of Biostatistics, Department of Community Medicine, Faculty of Medicine, IMS, BHU, Varanasi 221 005. India.

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Abstract

Ayurveda has advocated the *Dhatu sara pareeksha* under *Dashvidha Aatura Pareeksha* (ten ways to examine the patient) for the assessment of the functional state of *Dhatu* (bodily tissues) and *Manas* (Mind). The body is composed of *Dosha*, *Dhatu* and *Mala*. There are seven types of *Dhatu*, which refer to the structural component and functional framework of the body, playing a pivotal role in maintaining health and well-being. However, there are individual differences in the functional state of *Dhatu* inherently as per *Prakriti* (psychosomatic constitution). *Sara* refers to the best form of *dhatu* that signifies to determine an individual's *Bala* (biological strength of body and mind), and age of the patient. Assessment of *Dhatu Sarata* is particularly beneficial in numerous domains, such as evaluating strength (*Bala*), Immunity (*vyadhikshamatva*), and the management of disease. To examine *Sara*, certain characteristics related to each type of *Dhatu* have been described, which may be categorised as physical, physiological and psychological traits. In the characteristics of *Asthisara Purush*, the size, prominence and measurement of certain bones and joints have been mentioned that are big and prominent along with certain psychological traits. Although the *Dhatu sara* assessment profoma is available but no validated tool is available to assess the *Asthisara* with certain objective parameters. Thus, there is a need to develop a validated *Asthi Sara* Assessment Inventory (ASAI) to ensure inclusivity, reproducibility, and ease of use for clinical and research purposes.

Keywords: *Dhatu*, *Sara Pariksha*, Physical and psychological Traits, *Asthi Sara* Assessment Inventory (ASAI), Health

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Introduction

Ayurveda has considered the *dosha*, *dhatu* and *mala* as the three essential components of the body. The body is composed of seven *Dhatu*s, but there are individual differences in the functional state of *Dhatu*s. The *Dhatu Sarata* is influenced by several factors viz. *Vaya* (age), *Prakriti* (psychosomatic constitution), functional state of *Agni*, and *Ahaar Matra* (quantity of diet). *Sara Pariksha* is employed to determine an individual's *Bala* (biological strength of body and mind), and the age of the patient. It is one of the ten ways to assess the patient (*Dashvidha Aatura Pareeksha*). *Dasha Vidha Pareeksha* includes *Prakriti*, *Vikriti*, *Sara*, *Samhanana*, *Pramana*, *Satmya*, *Satva*, *Ahara Shakti*, *Vyayama Shakti*, and *Vaya*. (1) Based on the qualities of seven *dhatu* (tissues) and *Satva* (mind), *Charak* described eight categories of *Sara* (2). *Charaka* and *Sushruta* have provided precise descriptions of the physical and physio-psychological traits belonging to each *dhatu*. These parameters and characters help to determine the strength of a

person. *Sara Pariksha* can be carried out in both diseased as well healthy individual to assess the *Bala Pramana*.

Significance of *Sara* assessment

Sara refers to the best form of *dhatu* that signifies the strength of *dhatu* and its ability to withstand the disease. *Charak* has emphasized that the intrinsic strength of an individual cannot be evaluated just on the physical volume and dimensions of their body, but rather be determined by the functional state of *Dhatu* (tissue) and *Satva* (mind) under *Sara* examination. Assessment of *Dhatu Sarata* is particularly beneficial in numerous domains, such as evaluating strength (*Bala*), Immunity (*vyadhikshamatva*), and the management of disease. The *Sara Pariksha* is valuable in comprehending an individual's physical and psychological resilience. Additionally, it aids in accurately determining the appropriate dosage and kind of medication to be provided based on the patient's strength.

Need for the development of a new tool for the assessment of *Asthi Sara*

A few subjective proformas based on qualities stated in *Ayurveda Samhita* had been developed for the assessment of overall *Dhatu Sarata* based on characteristics of the seven *dhatu*, though they were not designed specifically for *Asthi Sara*. However, these methods of interrogation, examination, palpation, or anthropometric measures for body proportions described in

* Corresponding Author:

Vandana Verma

Department of Kriya Sharir,

Faculty of Ayurveda, IMS,

BHU, Varanasi 221 005. India.

Email Id: vandana.verma04@gmail.com

Angula Praman exhibit individual differences in capturing features. The assessment of *Sara* requires the application of standard scientific methodologies to precisely capture these characteristics, therefore ensuring accuracy and consistency.

In the prior *Sara* assessment tools, directly translated questions can produce subjective biases while assessing, and the questionnaire is entirely based on the *Charaka Samhita*. The scoring method for *Asthi Sara's* assessment and anthropometric vs. psychological aspects is unclear. Because of the aforementioned issues and the lack of a standardised tool in this domain, the researcher made an effort to develop the "*Asthi Sara* Assessment Inventory (ASAI)".

Background content of questionnaire development

The items of the *Asthi Sara* Assessment Inventory (ASAI) were based on the descriptions of the characteristics of *Ashti Sara Purush* described in *Charak Samhita*, *Sushruta Samhita*. The assessment of *Sara* (*Sara Pareeksha*) includes the evaluation of the functional state of seven tissues, i.e. *Rasa*, *Rakta*, *Mansa*, *Meda*, *Asthi*, *Majja* and *Shukra*, along with the Assessment of Mental strength, i.e. *Satva Sara*. The assessment of *Sara* provides information about the overall physical and mental strength of the subject. To examine *Sara*, certain characteristics related to each type of *Sara* have been described, which may be categorised as physical, physiological and psychological traits.

Physical and Physio-Psychological Characteristics of *Asthi Sara Purusha*

In the characteristics of *Asthisara Purush* the size, prominence and measurement of certain bones and joints have been mentioned that are big and prominent along with certain psychological traits.

The bone size has been measured through standard Anthropometric measurement and to assess the physiological and psychological traits certain questions based on described characteristics have been designed.

Characteristics of *Asthi Sara* described by *Charaka*:

Physical Traits

The heel (*Paarshnee*), ankle (*Gulfa*), knee (*Janu*), forearm (*Aratni*), clavicle (*Jatru*), Chin (*Chibuka*), head (*Shira*), joints of the finger (*Parva*) are *sthoola* i.e., these bony parts are big/ broad and prominent (3).

Physio-psychological Traits

- Enthusiastic and energetic (*Mahotsaha*)
- Active/prompt in works (*Kriyavanta*)
- Able to bear pain/stress (*Kleshasaha*)
- Stable, firm and strong body (*Sara-Sthira-Sharira*)
- Long life (*Aayushmanta*)

Characteristics of *Asthi Sara* described by *Sushruta*:

Asthi Sara individuals possess a big head, shoulders, strong teeth, jaws, bones, and nails (4).

Materials and Methods

Objective of the Study

Development of a validated *Asthi Sara* Assessment Inventory (ASAI) having more objectivity so that results can be reliable and reproducible.

Ethical Clearance

This tool development is a part of the MD thesis research work. The research proposal was duly approved by the Institutional Ethical Committee, IMS, BHU, Varanasi and PG Medical Board, Institute of Medical Science, Banaras Hindu University, Varanasi (letter No. Dean/2022/EC/3577), dated 20.10.2022.

Population and Sample

For the pilot study, healthy volunteers aged 20-40 years were registered from the student community (undergraduate, research scholars) of various streams in Banaras Hindu University. Only those who were clinically fit and provided written consent to participate willingly were registered.

Designing of *Asthi Sara* Assessment Inventory (ASAI)

Literature search for items generation

Charak Samhita and *Sushruta Samhita* were taken into consideration as a very initial phase in the item search. The distinctive characteristics of *Asthi Sara purusha* were systematically organised, and a comprehensive collection was created. The meanings of all the characteristics were verified by the Monier-Williams Sanskrit-English dictionary (5), commentaries on Samhita and English translations were then cross-checked by the Ayurveda experts.

Some traits which are repetitive or have similar meanings were removed, and the final constructs (traits) that are to be taken into account were listed with their meanings.

Preparation of the first draft of the scale

Keeping all the desirable conditions of a good scale in mind, the first draft of the questionnaire, the *Asthi Sara* Assessment Inventory (ASAI), was prepared based on physio-psychological traits. Self-administering close-ended types of questions were framed for each enlisted construct. The questions were designed in a manner that justifies each respective trait. Lead questions, double questions, and questions involving double negatives were avoided. The effort was made to frame questions which could be easily understood by the respondents and encourage them to provide precise, unbiased and complete information.

Editing of the first draft

After preparing the first draft of the scale, it was sent to the different experts of *Ayurveda* to get their opinions and suggestions for the appropriateness and relevance of the scale items. The intended questions went through several revisions and modifications as per the input of experts.

Pilot study

The first draft was administered to 60 BAMS students of Banaras Hindu University, Varanasi and a pilot study was performed to validate the ASAI questionnaire. During these activities, some difficulties which the respondents raised were marked. Most of the difficulties were related to language. The respondents who answered the items found the inventory satisfactory to comprehend and respond.

Preparation of the final ASAI

Adequate revisions in the scales, as felt during the pilot study, were done while preparing the final version of the *Asthi Sara* Assessment Inventory (ASAI). The characteristics of the processing of the final ASAI are as follows:

Generation of items and scale

The developed *Asthi Sara* Assessment Inventory (ASAI) consists of questions on the characteristics of *Asthi Sara Purush*. The questionnaire was designed with two major traits: i.e. physical and

psychological. In physical traits, a total of 11 anthropometric measurements were included, and in psychological traits, a total of 9 questions were framed, which are marked as Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9.

Proforma for Asthi Sara assessment

Department of Kriya Sharir, Faculty of *Ayurveda*, IMS, BHU

Name: Age: Gender: Mob. No.: Occupation: Address:

Anthropometric measurements: Height (cm), Weight (Kg), BMI (kg/m²), Waist Circumference (cm), Hip Circumference (cm), Waist-Hip Ratio.

1. Physiological and Psychological traits

Sr. no.	Physiological and Psychological traits:	0	1	2	3	4
Q1.	Are you enthusiastic and active in daily routine life	Never	Rarely	Occasionally	Frequently	Always
Q2.	Do you actively participate in different new assignments.	Never	Rarely	Occasionally	Frequently	Always
Q3.	Do you like to actively participate in sports and athletic activities	Never	Rarely	Occasionally	Frequently	Always
Q4.	Do you easily withstand the challenges, opponents, trials, and tribulations of life without getting stressed?	Never	Rarely	Occasionally	Frequently	Always
Q5.	Are you able to bear physical pain (traumatic pain etc.) and adverse conditions in your body?	Never	Rarely	Occasionally	Frequently	Always
Q6.	Are you able to keep yourself calm in the stressful/ critical conditions?	Never	Rarely	Occasionally	Frequently	Always
Q7.	Do you experience chronic stress or have high stress levels?	Never	Rarely	Occasionally	Frequently	Always
Q8.	Is any kind of physical or mental stress affecting your regular work and mental state	Never	Rarely	Occasionally	Frequently	Always
Q9.	Do you easily get affected by ailments related to seasonal variation- like skin allergies, common cold flu, viral infection, fever etc?	Never	Rarely	Occasionally	Frequently	Always

2. Physical Traits – Anthropometric measurements of bony parts mentioned in *Asthi Sara's* Characteristics.

Sr. no.	Body parts	Measurement (cm)	Measurement (angula A ⁰)	Average size	On inspection, Protuberant / broader in size
1	Head circumference				
2	Forehead width				
3	Mandible (Jaw bone)				
4	Length between tip of middle finger to elbow				
5	Shoulder width				
6	Hand Length				
7	Mid Arm Circumference				
8	Width of the middle finger				
9	Wrist joint circumference				
10	Knee joint circumference				
11	Ankle width				

Response format for capturing the Physio-psychological traits:

To collect the responses from the respondents, a five-point Likert scale has been chosen, where responses are measured along a range. The 5-point response (Likert) format chosen in this study is as follows:

Scoring Pattern

Each item of the Likert scale was analyzed separately in accordance with the numerical code allotted to the different points of the scale.

0= Never (), 1 = Rarely (), 2= Occasionally (), 3= Frequently (), (4= Always ()) for Q1, Q2, Q3, Q4, Q5, Q6, = Scoring pattern will be 0,1,2,3,4 for Q7, Q8, Q9 = Scoring pattern will be reversed 4,3,2,1,0.

Standardization and Validation of the Asthi Sara Assessment Inventory (ASAI) The sequence of outcomes of tests construction to establish the *Asthi Sara* Assessment Inventory are discussed as follows: A 9-item, 5-point scale (score 0 to 4) has been developed to determine the *Asthi Sara*. Reliability, Validity and cutoff of the scale are obtained by conducting a pilot study on 60 subjects.

Reliability: The reliability (Internal Consistency) has been measured by calculating Cronbach's alpha value and Guttman Split-Half Coefficient.

Cronbach's Alpha: Cronbach's alpha is a metric used to quantify internal consistency, or how closely linked a collection of items is to one another. It finds application within the framework of multi-item measuring tools.

Table 1. Internal Consistency/Reliability Coefficients for Asthi Sara Assessment Inventory (ASAI)

Reliability Statistics		
Cronbach's Alpha	No. of Items	No. of Subjects
0.760	9	60

For the reliability of the ASAI, the questionnaire was administered to 60 healthy volunteers to get the Cronbach's alpha. Table number 1 suggests that Cronbach's Alpha coefficient for the *Asthi Sara* Assessment Inventory (ASAI) over 9 constructs of the scale is 0.760, which may be considered satisfactory. The value of reliability measures above 0.7 is considered satisfactory (J Martin Bland and Douglas G Altman, 1997). The value of Cronbach's Alpha does not increase much if any of the items are deleted. Only Q7, if deleted, the value will increase to 0.77 from 0.76, as the increase in value is very small, so Q7 is retained in the scale.

Table 2. Details of Item and Cronbach's Alpha

Item-Total Statistics				
	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	20.38	23.257	0.342	0.751
Q2	20.60	23.295	0.346	0.751
Q3	20.42	21.434	0.442	0.738
Q4	20.67	20.463	0.584	0.715
Q5	20.93	20.165	0.542	0.720
Q6	20.70	19.807	0.623	0.707
Q7	20.62	23.562	0.221	0.771
Q8	20.73	22.097	0.372	0.749
Q9	20.95	20.726	0.480	0.731

Table 2 shows the relative contribution of constructs to the scale's reliability. All the values of corrected item-total correlation are more than 0.30, except Q7, for which the value is 0.221; this is also considered satisfactory. Thus, the items of *Asthi Sara* Assessment Inventory (ASAI) are reliable and adequate. The Item's total statistics showed that none of the items, if deleted, will increase the reliability coefficient much.

Guttman Split-Half Coefficient

Guttman Split-Half Coefficient is another measure to estimate the internal consistency of constructed items. It is a quite good measure of reliability and generates a higher value than Cronbach's Alpha because sometimes Cronbach's Alpha tends to underestimate the true reliability in a low empirical population. In Table number 3 its Value is more than 0.7, which is acceptable and quite good.

Table 3: Reliability Statistics

Cronbach's Alpha	Part 1	Value	0.704
		N of Items	5 ^a
	Part 2	Value	0.634
		N of Items	4 ^b
	Total N of Items		9
Guttman Split-Half Coefficient			0.635
a. The items are: Q1, Q2, Q3, Q4, Q5.			
b. The items are: Q5, Q6, Q7, Q8, Q9.			

Validity

a) Content Validity: Content validation of the *Asthi Sara* Assessment Inventory (ASAI) was done by collecting and compiling the references available in *Ayurvedic* literature. The respondents designed for each item were also cross-validated by *Ayurvedic* experts.

b) Face validity: Face validity of the *Asthi Sara* Assessment Inventory (ASAI) is tested by sending the questionnaire to 10 experts. None of the experts has deleted or added any item. Some minor suggestions from experts have been incorporated. All the respondents who answered the questions found it relevant to understand and respond.

c) Construct Validity: Construct Validity is the appropriateness of inferences made based on measurements: i.e. whether a test measures the intended construct or not. By investigating the information and verifying predictions, exploratory factor analysis (EFA) is frequently the initial stage in defining scales or a new measure (Samuels, 2016). Construct validity of the *Asthi Sara* Assessment Inventory (ASAI) was ascertained by comparing the responses of 60 respondents. A Factor Analysis was performed by applying Kaiser-Meyer-Olkin (KMO) Measures of Sampling Adequacy, also called Bartlett's Test of Sphericity in the obtained scores, which yielded the following values mentioned in Tables 4, 5 and 6.

Table 4 Factor Analysis KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.780
Bartlett's Test of Sphericity	Approx. Chi-Square	112.251
	Df	36
	Sig.	0.000

The obtained results of KMO and Bartlett's test are satisfactory. Further, the anti-image correlation matrix showed all the diagonal values being more than 0.50, which is considered acceptable.

Table 5: Total Variance Explained

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.186	35.395	35.395	3.186	35.395	35.395	2.226	24.733	24.733
2	1.420	15.779	51.174	1.420	15.779	51.174	1.638	18.197	42.930
3	0.853	9.478	60.652	0.853	9.478	60.652	1.595	17.722	60.652
4	0.797	8.858	69.509						
5	0.731	8.127	77.636						
6	0.616	6.844	84.480						
7	0.587	6.517	90.998						
8	0.463	5.141	96.139						
9	0.347	3.861	100.000						

Factor analysis identified 3 factors with a cumulative percentage of variance explained as 61 % which may be considered adequate.

Table 6: Shows the rotated factor matrix

	Component		
	1	2	3
Q1	0.259	0.635	-0.081
Q2	0.198	0.778	-0.102
Q3	0.083	0.624	0.507
Q4	0.816	0.207	0.028
Q5	0.696	0.341	0.021
Q6	0.676	0.224	0.331
Q7	0.120	-0.160	0.743
Q8	0.184	0.054	0.774
Q9	0.677	0.031	0.241

Table 7: The 3-dimensions (area)with items

Dimensions	Items
Dimension-1	Q4, Q5, Q6, Q9
Dimension-2	Q1, Q2, Q3
Dimension-3	Q7, Q8

The cutoff score of the scale:

To determine the cutoff score of the scale, the total score of 9 items has been calculated for all 60 subjects. The scale is 5 points (0 to 4), so the minimum and maximum total scores can be 0 and 36, respectively. Thus, to divide the total score range (0-36) into three categories, the mean $\pm$ SD approach is tested first. Summary statistics of the total score are shown in Table 8 below.

Table-8: Summary statistics of the total score

Total Score	Statistic	Std. Error
Mean	23.2500	0.66580
95% Confidence Interval for Mean	Lower Bound	21.9177
	Upper Bound	24.5823
5% Trimmed Mean	23.2593	
Median	23.0000	
Variance	26.597	
Std. Deviation	5.15727	
Minimum	12.00	
Maximum	33.00	
Range	21.00	
Interquartile Range	7.50	
Skewness	-0.093	0.309
Kurtosis	-0.631	0.608

mean $\pm$ SD approach is followed if the data follows normal distribution and here the test of normality as shown in table no. 9 below shows that data follows normal distribution as test statistics are not significant.

Table 9. Showing Tests of Normality i.e. Kolmogorov-Smirnov and Shapiro-Wilk for determination of cut-off score for *Asthi Sara* Assessment Inventory (ASAI)

	Tests of Normality					
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Total Score	0.114	60	0.05	0.972	60	0.178

Table 10: The cutoff has been determined based on the mean $\pm$ SD values provided in the following table.

Total Score	Asthi Dhatu Status
0 – 17	Low (<i>Avara Sara</i>)
18 – 28	Average (<i>Madhyam Sara</i>)
29- 36	Good (<i>PrAvara Sara</i>)

Discussion

To assess the *Asthi Sara* a validated *Asthi Sara* Assessment Inventory (ASAI) was developed based on characteristics of *Asthi Sara Purush* described in *Ayurveda* by following all the essential protocols needed for validation of a questionnaire.

The *Asthi Sara* individuals possess a big head, shoulders and strong teeth, jaws, bones, and nails. Similarly, to describe the bone size in the traits of *Asthi Sara Purusha*, the “*Sthoola*” (~big/ broad and prominent), word has been used, which is difficult to record subjectively and based on this, categorize into *Pravar*, *Madhyam* and *Avar* in *Asthi Sara*. However, we have enlisted all those bony parts like the heel (*Paarshnee*), ankle (*Gulfa*), knee (*Janu*), forearm (*Aratni*), clavicle (*Jatru*), Chin (*Chibuka*), head (*Shira*), joints of the finger (*Parva*) and measurements were taken by standard anthropometric methods.

This scale is comprised of two parts:

1. Based on Physio-psychological traits the questionnaire comprised of 9 question sets.
2. Anthropometric measurements of certain bones are described as characteristic of *Asthi Sara*.

However, this tool consists of two parts, but the categorisation of *Asthi Sara* into *PrAvara*, *Madhyam*, and *Avara* is only based on a Physio-psychological questionnaire due to the non-availability of the data related to the classification of the bony framework based on Anthropometric measurements in the adult Asian population.

The anthropometric measurements of bones are recorded to generate primary data of the adult Indian population to categorise the size of different bones and skeletal framework into large, medium and short and to study the association between Anthropometric measurements and Physio-psychological traits. In the pilot study, the correlation between the Physio-psychological scores and the anthropometric measurements was also analyzed, and some significant observations have been obtained.

The ASAI is comprised of 9 questions related to Physio-psychological traits, having response patterns in the form of a five-point Likert scale with an allotted score of 0-4. The tool was validated by conducting a pilot study on 60 healthy subjects. The Cronbach alpha and Guttman's lambda of items are 0.760 and 0.635, respectively, which suggests that the tool is valid and acceptable for administration. The range of scores on the scale is a minimum of 0 to a maximum of 36. Based on the score of the Physio-psychological traits of *Asthi Sara*, it is categorized into three categories i.e. *Avara* (0-17), *Madhyam* (18-28) and *Pravar Asthisara* (29-36).

Conclusion

The different steps of the proforma tool development suggest that the developed *Asthi Sara* assessment tool is statistically valid and may be used for research purposes. Further studies are recommended to establish its utility across diverse populations and clinical conditions.

Limitations

It's very difficult to measure the Physical and psychological traits because of the unavailability of previous data related to these traits. Similarly, no clear-cut dimensions of anthropometric traits have been described, even in *Angula Pramana*, to categorise into *Pravara*, *Madhyam* and *Avara Athi Sara*. The categorization of *Asthisara* based on inspection of bones in terms of *Sthula*, Prominence of the bone is very subjective, and there are great chances of biases.

The Skeletal framework categories, i.e. large, medium, and short, have not been described yet on objective Anthropometric parameters in the Indian population. There is a need for a large population-based collection of Anthropometric data for the categorization of skeletal framework.

This proforma has closed-ended questions, and responses are self-reported, so it may have response biases. An unremitting effort is needed to incorporate more objective parameters in such tools to have an accurate, precise, and objective methodology for such Assessment tools.

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