National Council on Strength & Fitness

Certified Personal Trainer Examination

Certified Strength Coach Examination

NCSF™

Annual Exam Report

January 1 to December 31, 2017

April 12th 2018

PROMETRIC
Test Development Solutions ™

BACKGROUND

The National Council on Strength and Fitness (NCSF) is a professional, member-driven, education and credentialing organization for personal trainers and exercise science professionals. The NCSF is committed to serving the public through research, service, and advancement of the certified strength coach profession.

The NCSF sponsors the Certified Personal Trainer examination. The purpose of this report is to document the test and item analysis performed by Prometric Test Development Solutions in an effort to evaluate the psychometric quality of the examination for the year 2017.

COMPREHENSIVE TEST DEVELOPMENT

In cooperation with Prometric Test Development Solutions, the NCSFBC develops and administers a legally defensible, psychometrically sound examination. The processes and procedures used to develop and maintain these exams are summarized in the table below.

Test Design	Job Analysis	Define the tasks, knowledge, and skill important for performing the specified role
	Test Specifications	Subject matter experts (SMEs) review the importance and determine how many items should be written to each objective
	Test Definition	Defines the purpose, scope, target population, general topics, duration, number of forms, number of items and types of items
Item Development	Item Writing	Provide training on item writing to meet the test specifications and amounts listed in the blueprint
	Technical Item Reviews	Review items for language and technical accuracy
Psychometrics	Item Analysis	Compute statistics that measure item performance
	Item Selection	Assign items for inclusion on final forms, discarding or rewriting
	Form Assembly	Distribute items across forms so that each form meets the specifications of the blueprint plan and remain equally difficult
	Beta Test	Evaluate items and examinations before scored use
	Standard Setting	Set the cut score
In-service	Maintain Exams	Conduct ongoing analysis of item and test statistics and revise test periodically

TEST DESIGN: CONDUCTING A JOB ANALYSIS STUDY TO DETERMINE TEST SPECIFICATIONS

NCSFBC test design process starts by conducting a job analysis. Job analysis process is designed to determine the tasks performed on a job as well as the critical knowledge and/or skills needed to adequately perform those tasks. For purposes of developing NCSFBC examinations, the job analysis identified important tasks and knowledge necessary for competent performance as a personal trainer. Job analysis is also a highly appropriate and useful method for gathering information to inform continuing education and professional development efforts.

ITEM DEVELOPMENT: VALID PROCESSES FOR DEVELOPING TEST ITEMS

The NCSFBC and Prometric work together to write relevant examination items and construct valid test forms according to the approved test specifications. Prometric test developers assists NCSF subject-matter experts in writing and reviewing exam items to achieve the following outcomes:

- The option indicated as the item key has been correctly identified.

- The language of each item is clear and unambiguous.

- The item is appropriately classified in terms of the test plan or blueprint; and valid references have been provided.

- Items are appropriately difficult and not encumbered with irrelevant sources of difficulty (such as inappropriately complex sentence construction or difficult vocabulary).

- Items are free from content inaccuracies.

- Language, symbols, words, phrases, or examples that can be regarded as sexist, racist, or otherwise potentially offensive, inappropriate, or negative toward any group is identified and removed. Additionally, each item is reviewed for possible bias in language or social context.

PSYCHOMETRICALLY SOUND TEST CONSTRUCTION PROCESSES FOR VALID EXAMS

NCSFBC approved examination items are assembled into multiple test forms in accordance with the pre-determined test specifications, ensuring that the appropriate number of items from each knowledge, skill or ability area is incorporated in to each form. As one or more test forms are assembled, pretest and operational test item data is used to anticipate the statistical characteristics of each form. This data is used to verify adequate test functioning and test form comparability. Test analysis assures that test forms exhibit expected pass rates, adequate reliability and pass/fail decision consistency,

tolerable measurement error, expected item response consistencies and interrelationships between test parts, adequate response times and comparability between forms. These attributes are critical to valid interpretation and use of test scores.

ITEM ANALYSIS FOR EXAM MAINTENANCE

A key contributor to examination validity is regular analysis of exam-level and item-level statistics. Prometric's staff of expert psychometricians analyze NCSFBC examination items and produce detailed item analysis reports for test review and development meetings. There are four main objectives of classical item analysis:

1. Confirm that each item has an expected and appropriate level of difficulty.

2. Determine the degree to which performance on each item is an indicator of performance on the overall test (discrimination).

3. Determine if candidates are selecting or constructing an answer to the item in a way that is consistent with a well-formed test item.

4. Establish item parameter estimates for assigning items appropriately to test forms.

Item analysis generates statistics that assess item and exam performance against the above objectives. These statistics allow our analysts to observe item-level and exam-level characteristics, such as:

- The proportion of candidates answering each question correctly.
- The correlation between the question score (correct or incorrect) and the total test score.
- The correlation between distracters and the total test score.
- The average score for the total test and each of its subsections.
- The pass ratio for each test.
- The reliability of each test.

STANDARD SETTING PROCESS TO DETERMINE A PASSING SCORE FOR EACH EXAM

The NCSFBC establishes and validates an appropriate minimum passing score for each examination using the Modified Angoff and Beuk Relative-Absolute Compromise methodologies for standard setting. It is extremely important to set the cut score appropriately for each examination. If the cut score is set too high, qualified people will fail the examination. If the cut score is set too low, unqualified candidates will pass. The cut score is a policy judgment, but it must be defensible because of the societal and personal consequences that flow from it. The NCSFBC ensures that the established cut score is reasonable and is based on qualified judgment and empirical evidence.

THE CERTIFIED PERSONAL TRAINER EXAM

The Certified Personal Trainer exam is a computer based test. The candidates need to complete the examination within 180 minutes. Two forms (Form I and Form J) were in the field in 2017. Each form consisted of 150 multiple-choice items, including 125 operational, scored items and 25 pretest, unscored items. The cut score to pass the examination is 72 on form I and 73 on form J (i.e., 58% of operational items with normal rounding on Form I and 58% of operational items rounded down on Form J).

TEST FORM ANALYSIS

Table 1 provides the summary statistics of the NCSF examination for each form. The table includes the total number of candidates, pass rates for forms, the number of scored (operational) items in the examination, the score range (i.e., minimum and maximum total raw score), the median score, the mean score, the standard deviation of scores, and the skewness and kurtosis of the score distribution. The overall proportion of candidates passing the NCSF CPT examination (on both forms combined) in 2017 was 0.7986 or 79.86% given the cut scores.

The skewness indicates the degree of asymmetry in the distribution of scores. A positive value indicates that the tail of the distribution stretches toward higher scores; a negative value indicates that the tail extends toward the lower scores. The kurtosis indicates the degree of peakedness in a distribution of scores. The Pearson Kurtosis of a normal distribution is 3.0. As Figure 1 and Figure 2 also show, the score distribution of the NCSF CPT examination forms are close to normal (skewness values of form I and J respectively are -0.60 and -0.42), and are also close to normal with respect to kurtosis (2.53   and   2.25).

Table 1: NCSF CPT Exam Summary Test Statistics, January 1, 2017 — December 31, 2017

	Form I	Form J
Number of candidates	1246	1222
Proportion passing	0.827	0.770
# of operational Items	125	125
Maximum score	124	123
Median score	94	92
Minimum score	33	33
Mean score	90.93	87.76
Standard Deviation of scores	18.32	19.78
Skewness	-0.60	-0.42
Kurtosis	2.53	2.25
Summary Item Statistics		
Mean Item Difficulty (P+)	0.73	0.71
St. Dev. of Item Difficulty	0.14	0.13
Mean Item Discrimination (Biserial)	0.50	0.50
St. Dev. of Item Discrimination	0.16	0.14

Table 1 also includes the mean and the standard deviation for the item difficulty index (P+) and item discrimination (point-biserial correlation and biserial) for each form. The difficulty index indicates the proportion of candidates that answered the item correctly. The mean P+ is the average of the proportions of candidates answering the items correctly averaged across all items included in the score. The standard deviation P+ is the standard measure of dispersion of P+ values around the mean P+.

The point-biserial correlation is the Pearson Product-Moment correlation. It correlates how candidates score on individual dichotomously-scored (correct or incorrect) items with how they score on the exam overall, so it is called an item-total correlation and is an indication of how well individual items discriminate between higher ability and lower ability candidates. A high positive point-biserial correlation suggests that candidates who performed well on the item also performed well overall, while candidates who did not perform well on the item did not perform well overall. The mean point-biserial correlation is the average of the item-total correlations averaged across all items included in the score. Biserial correlation is another kind of item-total correlation that is used with a dichotomized variable (correct vs. incorrect item scores) and a continuous variable (total scores). It assumes the continuous variable is normally distributed, tends to be systematically larger than the point-biserial correlation, and differs from the point-biserial correlation more at the extremes of the distribution. The standard deviation of a biserial correlation is the standard measure of dispersion of biserial correlations around the mean biserial correlation.

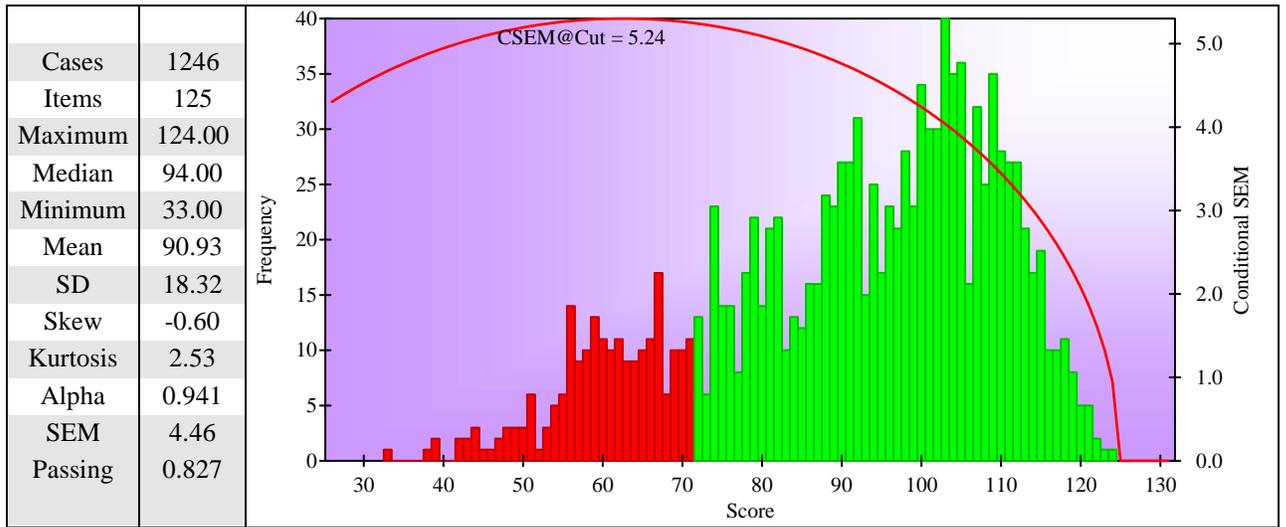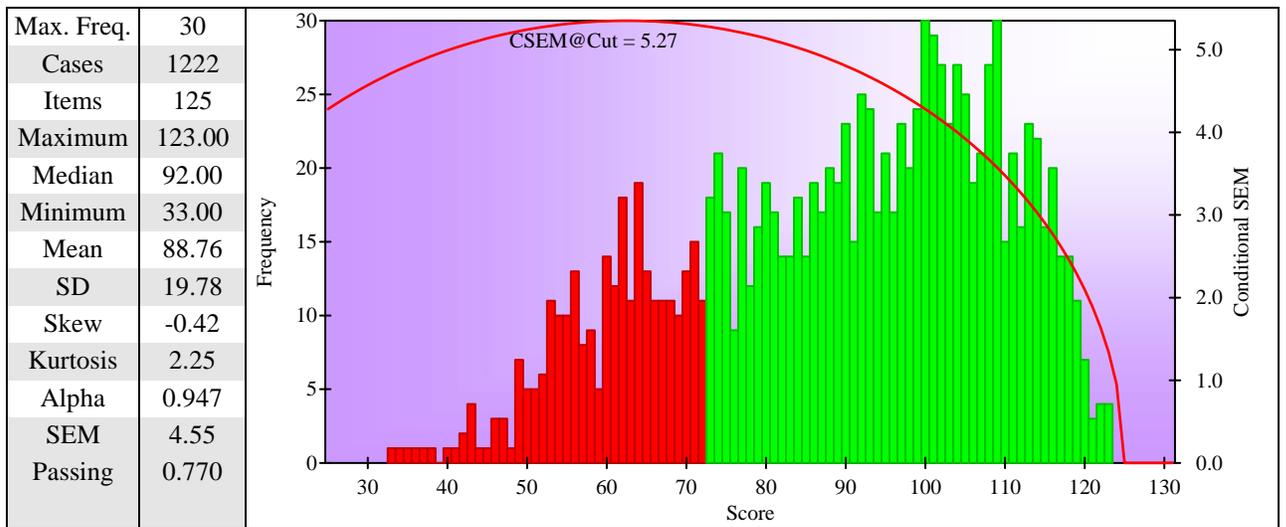Figure 1: NCSF CPT Exam Form I Score Frequency Distribution 2017

Cases	1246
Items	125
Maximum	124.00
Median	94.00
Minimum	33.00
Mean	90.93
SD	18.32
Skew	-0.60
Kurtosis	2.53
Alpha	0.941
SEM	4.46
Passing	0.827

Figure 2: NCSF CPT Exam Form J Score Frequency Distribution 2017

Max. Freq.	30
Cases	1222
Items	125
Maximum	123.00
Median	92.00
Minimum	33.00
Mean	88.76
SD	19.78
Skew	-0.42
Kurtosis	2.25
Alpha	0.947
SEM	4.55
Passing	0.770

RELIABILITY AND DECISION CONSISTENCY STATISTICS

Internal consistency reliability estimates were computed using Cronbach's coefficient alpha (Cronbach, 1951) among each of the scales in the test, given by:

$$\alpha_X = \frac{n}{n-1}\left(1 - \frac{\sum S_i^2}{S_x^2}\right)$$

where n is the number of items, $\sum S_i^2$ is the sum of the item variances, and S_X^2 is the variance of score X. Cronbach's alpha is a generalization of the KR20 when data are dichotomous.

The SEM is an estimate of the standard deviation of the distribution of observed scores around the true score. The SEM can be interpreted as an index of expected variation occurring if the same examinee was tested repeatedly on different forms of the same test without benefiting from practice or being hampered by fatigue.

The SEM of a raw score is computed from the reliability estimate (a_x) and the standard deviation (SD_x) of the scores by the formula:

$$SEM_X = SD_X \sqrt{1 - \alpha_X}$$

Table 2 below presents the internal consistency reliability estimate (KR-20) and the associated standard error of measurement for the total Forms I & J and for each domain in each of the two forms and for the total.

Table 3 below reports the Decision consistency. Decision consistency measures the extent to which classifications based on test scores match the decisions based on scores from a second, parallel form of the same test. The single decision consistency estimates using formula presented by Subkoviak (1976) and the conditional SEM (CSEM) at the cut score are reviewed.

Decision consistency estimates were computed using the Subkoviak statistic. The Subkoviak statistic provides an estimate of the decision consistency of a pass/fail decision. Using the passing score selected, it estimates the probability that an individual would receive the same decision on two separate administrations of the test. The Subkoviak C statistic uses KR-20 (Alpha) as a reliability estimate and assumes that scores are characterized by the compound binomial distribution. The Subkoviak C is estimated as suggested by Lord and Novick (1968, p. 525).

Table 2: Reliability and SEM statistics for Forms I and J in total and by domain

Domain	# Items	Form I			Form J		
		Reliability	SD	SEM	Reliability	SD	SEM
Functional Anatomy	19	0.702	3.29	1.80	0.729	3.44	1.79
Exercise Physiology	12	0.624	2.25	1.38	0.633	2.29	1.39
Physical Activity and Health Promotion	8	0.500	1.42	1.00	0.612	1.63	1.01
Screening, Evaluation and Professional Practice	17	0.695	2.82	1.56	0.752	3.06	1.52
Nutrition	12	0.684	2.46	1.38	0.699	2.62	1.44
Weight Management	8	0.610	1.72	1.08	0.63	1.96	1.19
Exercise Prescription and Programming Considerations	23	0.749	3.99	2.00	0.799	4.32	1.94
Training Instruction	20	0.655	2.97	1.75	0.696	3.44	1.90
Considerations for Special Populations	6	0.637	1.62	0.98	0.455	1.42	1.05
Total Form Reliability Statistics	**125**	**0.941**	**18.32**	**4.46**	**0.947**	**19.78**	**4.55**

Table 3: Decision Consistency for Forms I and J

Form	N	Decision Consistency (Subkoviak Index)	Conditional SEM at cut score
Form I	1246	0.94	5.24
Form J	1222	0.92	5.27

SUMMARY OF STATISTICAL ANALYSIS

The overall passing rates for the NCSF CPT exam in 2017 are about 79.86%. The average total raw score of the NCSF CPT exam is 90.93 for Form J and 88.76 for Form J, respectively. The standard deviation of the total raw score ranged from 18.32 in Form I to 19.78 in Form J. The reliability coefficients of the NCSF CPT exam forms in 2017 are both above 0.90 and the SEMs for the two forms showed to be stable and acceptable from the comparison with the previous year's outcomes.

The total number of NCSF certified personal trainers at the time of this report is 7,543

References

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika. 16*, 297-334.

Subkoviak, M. (1976). Estimating reliability from a single administration of a criterion referenced test. *Journal of Educational Measurement, 13(4)*, 7-10.

Appendix A

Subkoviak (1976) Documentation

Subkoviak 1976.pdf

Certified Strength Coach Examination

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TEST ANALYSIS

Table 1 provides the summary statistics of the NCSF CSC examination. The table includes the total number of candidates, pass rates for forms, the number of scored (operational) items in the examination, the score range (i.e., minimum and maximum total raw score), the median score, the mean score, the standard deviation of scores, and the skewness and kurtosis of the score distribution. The overall proportion of candidates passing the NCSF CSC in the reporting period 2017 was 0.553 or 55.3% given the cut score (percentage cut = 60%; raw cut = 75).

The skewness indicates the degree of asymmetry in the distribution of scores. A positive value indicates that the tail of the distribution stretches toward higher scores; a negative value indicates that the tail extends toward the lower scores. The kurtosis indicates the degree of peakedness in a distribution of scores. The Pearson Kurtosis of a normal distribution is 3.0. As Figure 1 and Figure 2 also show, the score distribution of the NCSF CSC examination is close to normal (skewness values is 0.10), and is also close to normal with respect to kurtosis (2.67).

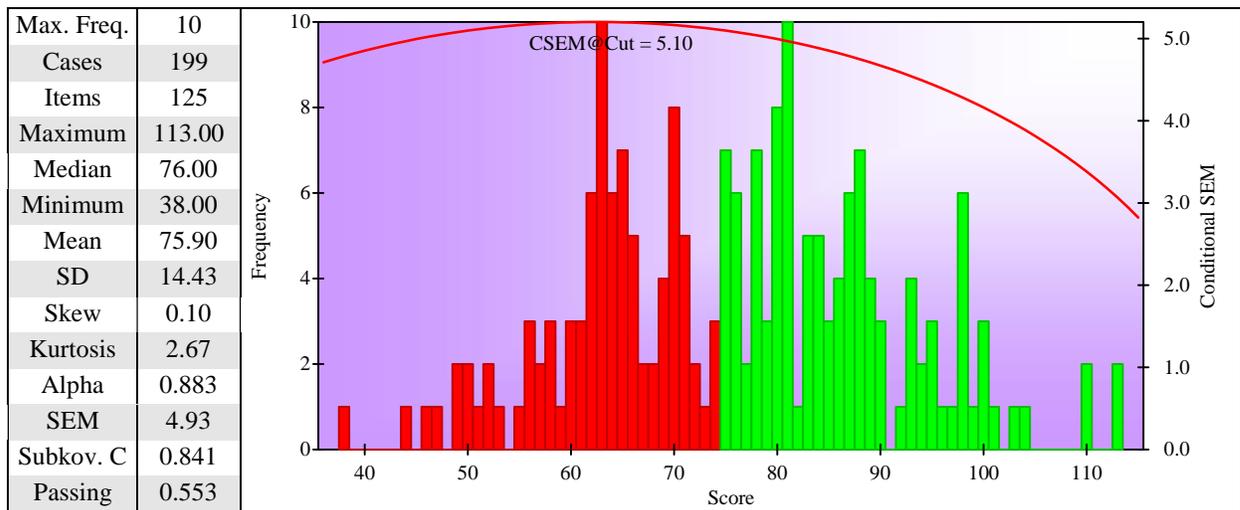**Table 1: NCSF CSC Exam Summary Test Statistics, January 1, 2017 — December 31, 2017**

	CSC
Number of candidates	199
Proportion passing	0.553
# of operational Items	113
Maximum score	134
Median score	76
Minimum score	38
Mean score	75.90
Standard Deviation of scores	14.43
Skewness	0.10
Kurtosis	2.67
Summary Item Statistics	
Mean Item Difficulty (P+)	0.61
St. Dev. of Item Difficulty	0.18
Mean Biserial Correlation	0.34
St. Dev. of Biserial Correlation	0.15

Table 1 also includes the mean and the standard deviation for the item difficulty index (P+) and two item discrimination measures, mean point-biserial correlation and mean biserial correlation. The difficulty index indicates the proportion of candidates that answered the item correctly. The mean P+ is the average of the proportions of candidates

answering the items correctly averaged across all items included in the score. The standard deviation P+ is the standard measure of dispersion of P+ values around the mean P+.

The point-biserial correlation is the Pearson Product-Moment correlation. It correlates how candidates score on individual dichotomously-scored (correct or incorrect) items with how they score on the exam overall, so it is called an item-total correlation and is an indication of how well individual items discriminate between higher ability and lower ability candidates. A high positive point-biserial correlation suggests that candidates who performed well on the item also performed well overall, while candidates who did not perform well on the item did not perform well overall. The mean point-biserial correlation is the average of the item-total correlations averaged across all items included in the score. Biserial correlation is another kind of item-total correlation that is used with a dichotomized variable (correct vs. incorrect item scores) and a continuous variable (total scores). It assumes the continuous variable is normally distributed, tends to be systematically larger than the point-biserial correlation, and differs from the point-biserial correlation more at the extremes of the distribution. The standard deviation of a biserial correlation is the standard measure of dispersion of biserial correlations around the mean biserial correlation.

Figure 1: NCSF CSC Exam Score Frequency Distribution Jan 1 2017 to December 31 2017

Max. Freq.	10
Cases	199
Items	125
Maximum	113.00
Median	76.00
Minimum	38.00
Mean	75.90
SD	14.43
Skew	0.10
Kurtosis	2.67
Alpha	0.883
SEM	4.93
Subkov. C	0.841
Passing	0.553

RELIABILITY AND DECISION CONSISTENCY STATISTICS

Internal consistency reliability estimates were computed using Cronbach's coefficient alpha (Cronbach, 1951) among each of the scales in the test, given by:

$$\alpha_X = \frac{n}{n-1}\left(1 - \frac{\sum S_i^2}{S_x^2}\right)$$

where n is the number of items, $\sum S_i^2$ is the sum of the item variances, and S_x^2 is the variance of score X. Cronbach's alpha is a generalization of the KR20 when data are dichotomous.

The SEM is an estimate of the standard deviation of the distribution of observed scores around the true score. The SEM can be interpreted as an index of expected variation occurring if the same examinee was tested repeatedly on different forms of the same test without benefiting from practice or being hampered by fatigue.

The SEM of a raw score is computed from the reliability estimate (α_X) and the standard deviation (SD_X) of the scores by the formula:

$$SEM_X = SD_X\sqrt{1 - \alpha_X}$$

Table 2 below presents the internal consistency reliability estimate (KR-20) and the associated standard error of measurement for the total Forms I & J and for each domain in each of the two forms and for the total.

Table 3 below reports the Decision consistency. Decision consistency measures the extent to which classifications based on test scores match the decisions based on scores from a second, parallel form of the same test. The single decision consistency estimates using formula presented by Subkoviak (1976) and the conditional SEM (CSEM) at the cut score are reviewed.

Decision consistency estimates were computed using the Subkoviak statistic. The Subkoviak statistic provides an estimate of the decision consistency of a pass/fail decision. Using the passing score selected, it estimates the probability that an individual would receive the same decision on two separate administrations of the test. The Subkoviak C statistic uses KR-20 (Alpha) as a reliability estimate and assumes that scores are characterized by the compound binomial distribution. The Subkoviak C is estimated as suggested by Lord and Novick (1968, p. 525).

Table 2: Reliability and SEM statistics for Form CSC1 in total and by domain

Domain	# Items	Form CSC1		
		Reliability (Cronbach's α)	SD	SEM
Functional Anatomy and Biomechanics	19	0.538	2.73	1.86
Sport Metabolism	13	0.415	2.16	1.65
Performance Assessment and Evaluation	16	0.532	2.53	1.73
Nutrition and Ergogenic Aids	10	0.307	1.52	1.27
Advanced Programming for Sport	25	0.525	3.34	2.30
Training Techniques for Athletic Performance	25	0.698	4.00	2.20
Injury Prevention and Return to Play	11	0.508	2.05	1.44
Professionalism and Risk Management	6	0.262	1.30	1.12
Total Form Reliability Statistics	**150**	**0.883**	**14.43**	**4.93**

Table 3: Decision Consistency for Form CSC1

Form	N	Decision Consistency (Subkoviak Index)	Conditional SEM at cut score
CSC	199	0.84	5.10

SUMMARY OF STATISTICAL ANALYSIS

The overall passing rates for the NCSF CSC exam in the period January 1, 2017 to December 31, 2017 is about 53.3%. The average total raw score of the NCSF CSC exam is 75.90. The standard deviation of the total raw score is 14.43. The reliability coefficient of the NCSF-CSC exam is above 0.85 and the SEMs for the exam is acceptable.

The total number of NCSF Certified Strength Coach as of December 31st 2017 is 181.

References

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika. 16*, 297-334.

Subkoviak, M. (1976). Estimating reliability from a single administration of a criterion referenced test. *Journal of Educational Measurement, 13(4)*, 7-10.

Appendix A

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