Title

Comparing tolerance of ambiguity in veterinary and medical students.

Authors

Jason Hancock; College House, St Luke's Campus, The University of Exeter. MBChB (Hons), MRCPsych. Higher Specialist trainee in Psychiatry, Devon Partnership Trust, University of Exeter Medical school. Jason.hancock@nhs.netmailto:

Jennifer A Hammond; Veterinary & Life Sciences, Bearsden Road, Glasgow, G61 1QH. VetMB MA. University Teacher in Veterinary Education, University of Glasgow School of Veterinary Medicine.

Martin Roberts; Plymouth University Peninsula Schools of Medicine and Dentistry, Drake Circus, Plymouth, PL4 8AA. BA, MSc. Lecturer in Assessment Psychometrics, Collaboration for the Advancement of Medical Education Research and Assessment (CAMERA).

Karen Mattick; University of Exeter, Heavitree Road, Exeter EX12LU, UK. PhD. Professor of Medical Education, Centre for Research in Professional Learning, Graduate School of Education, University of Exeter.

Abstract

Current guidelines suggest that educators in both medical and veterinary professions should do more to ensure that students can tolerate ambiguity. Designing curricula to achieve this requires the ability to measure and understand differences in ambiguity tolerance between and within professional groups. Although scales have been developed to measure tolerance of ambiguity in both medical and veterinary professions, no comparative studies have been reported. We compared the tolerance of ambiguity of medical and veterinary students, hypothesising that veterinary students would have higher tolerance of ambiguity, given the greater patient diversity and less well established evidence-base underpinning practice. We conducted a secondary analysis of questionnaire data from year 1-4 medical and veterinary students. Tolerance of ambiguity scores were calculated and compared using the TAMSAD scale (29 items validated for the medical student population), the TAVS scale (27 items validated for the veterinary student population) and a scale comprising the 22 items common to both scales. Using the TAMSAD and TAVS scales medical students had a significantly higher mean tolerance of ambiguity score than veterinary students (56.1 vs 54.1, $p>0.001$ and 60.4 vs 58.5, $p=0.002$ respectively) but no difference was seen when only the 22 shared items were compared (56.1 vs 57.2, $p=0.513$). The results do not support our hypothesis and highlight that different findings can result when different tools are used. Medical students may have slightly higher tolerance of ambiguity than veterinary students, although this depends on the scale used.

Keywords

ambiguity tolerance, uncertainty tolerance, veterinary students, medical students

Introduction

Ambiguity is inherent within both medical and veterinary practice due to limitations of knowledge, diagnostic uncertainty, complexities of treatment and outcome and unpredictability of patient response[1]. Investigating levels of tolerance of ambiguity in those training to enter medical and veterinary professions, and understanding whether levels of tolerance of ambiguity can change during the course of training, is of significant scientific and educational interest.

While many definitions of ambiguity and uncertainty exist we use the Collins English dictionary definition of ambiguity "vagueness and uncertainty of meaning" and Greco and Roger's definition of uncertainty "the response to an ambiguous situation", akin to a period of anticipation prior to confrontation with a potentially harmful event[2]. It is highly likely that avoidance of uncertainty is correlated with intolerance of ambiguity[3] however the two terms are not interchangeable.

In medicine intolerance of ambiguity has been linked with low patient and physician satisfaction, increased risk of physician burnout[4,5], a more negative attitude towards underserved populations[6] and personality traits such as dogmatism, conformity and rigidity[3,7]. The equivalent research with veterinary students has not yet been undertaken, due to a lack of appropriate measurement scales available. The topic of tolerance of ambiguity within veterinary practice, however, is just as important as for medicine and arguably more so. Veterinary professionals typically work across several animal species, and there is often a limited evidence base relating to each individual species when compared to human medicine. In addition, a greater degree of ambulatory practice frequently leads to high levels of independent working. Understanding ambiguity tolerance in veterinary students, and how it might change during undergraduate education, is therefore crucial for veterinary student educators[8].

The need for veterinary and medical students to tolerate ambiguity by the time that they enter professional practice has been emphasised for both professions in the documents 'Outcomes for graduates' by the General Medical Council (GMC)[9] for medical students, and 'Day one competencies' by the Royal College of Veterinary Surgeons (RCVS)[10] for veterinary students, although the term ambiguity is not always used. The GMC states that new doctors must be able to: '*Analyse complex and uncertain situations, make clinical judgments in situations of uncertainty, and deal effectively with uncertainty and change*' (Outcomes for graduates, GMC, 2015). In veterinary training the publication 'Day One Competencies' states that '*a new graduate who has achieved day one competence should be capable and confident enough to practise veterinary medicine at a primary care level on their own, while knowing when it is appropriate to seek direction from more experienced colleagues*' (RCVS 2014). Specifically they should: '*Demonstrate ability to cope with incomplete information, deal with contingencies, and adapt to change*' (RCVS 2014) a key component of which is being able to manage cases and make decisions where there is incomplete or unclear data.

While our understanding of ambiguity tolerance within the medical student population is growing many aspects of ambiguity tolerance in both the veterinary student and medical student population remain uncertain, including whether ambiguity tolerance is a stable trait or can change over time[11]. The ability to describe and understand differences between and within professional groups is an important endeavour in the current era of inter-professional working and there are a number of reasons why comparing ambiguity tolerance between medical and veterinary students is an important starting point. The 'One Health' agenda is just one example. The concept of One Health[12] emphasises the importance of health professionals and researchers working closely together as part of inter-professional expert teams and aims to develop a strong collaborative approach between veterinary and medical professions in areas such as emerging disease and outbreak management, where uncertainty and complexity are common.

There are already significant areas of shared practice between the medical and veterinary professions. Indeed, institutional structures in higher education frequently recognise this and group medical and veterinary schools together as part of colleges of health professions or life sciences education. This can result in close relationships between veterinary, medical and other health professions education and scope for developing inter-professional educational opportunities. These opportunities can only be optimised if there is a clear understanding of the similarities and differences between the student groups and the different professional trajectories.

While there have been many attempts to develop scales aiming to measure the construct of tolerance of ambiguity within the medical student population, until recently[8] no attempt had been made to develop a scale for use in the veterinary student population. No research, as far as we are aware, has attempted to compare levels of tolerance to ambiguity between veterinary student and medical student populations.

The TAMSAD (Tolerance of Ambiguity of Medical Students And Doctors) scale was developed and the evidence for its reliability and validity in the medical student and junior doctor population under investigation was promising[11]. This is a 29 item scale which was developed through a process of data analysis and refinement with 262 medical students at one medical school in the UK. Students were initially asked to respond to 41 clinically contextualised items. Following data analysis, items that did not contribute to the wider scale were removed leaving a 29 item scale that acted as unidimensional measure of tolerance of ambiguity. The Cronbach's alpha of 0.80 in the original study population indicates that it had good internal consistency in this setting.

This scale was recently modified for use in the veterinary student population through measuring the responses of a population of 292 Veterinary students at one veterinary school in the UK[8]. Following a process of refinement in light of data collected with veterinary students similar to that used for the original TAMSAD scale development the final 27 item TAVS (Tolerance of Ambiguity of Veterinary Students) scale was found to act as a unidimensional measure of tolerance to ambiguity with a Cronbach's alpha of 0.67. Both of these scales were developed from the same initial pool of 41 items and share 22 items, only subtly different in their wording.

Aim of current study

This study aimed to compare the tolerance of ambiguity of medical and veterinary students in the UK. Our hypothesis was that veterinary students would have higher tolerance of ambiguity, given the less well established evidence-base underpinning their work and the multiple animal species they may care for.

Methods

Study design

This is a secondary analysis of data collected for the original scale refinement studies for both the TAMSAD scale[11] and the TAVS scale[8]. While in the medical student study data were collected for all five years of the medical programme, the timing of survey points for the veterinary student study meant that this was only possible for the first four years of the five year undergraduate programme, since final year veterinary students were on distributed clinical placements.

Setting

The medical students were based in South West England in a medical school that uses problem-based-learning (PBL) across a 5 year degree programme. The first 2 years of this programme are spent predominantly in the academic environment, with the final 3 years spent in the clinical arena. Throughout the degree programme self-directed learning (SDL) is encouraged and periods of formal learning are interspersed with special study units (SSUs), providing students with the opportunity to research non-core topics in depth. Assessment is characterised by a little but often approach. Applied medical knowledge is assessed by a multiple choice progress test sat quarterly, and clinical skills are tested via regular competency assessments, with an additional integrated structured clinical examination (ISCE). In year 5 the focus is on preparation for work as a foundation year doctor. Although there are few specific taught sessions on tolerating ambiguity in the undergraduate medical programme, this is a principle that underpins the medical curriculum design through teaching and assessment. For example, the instructional methods, including problem based learning and clinical reasoning formative assessments, are purposefully selected to highlight the ambiguity that is inherent to medicine, to students at all stages of study, and this is reinforced through summative assessment.

The veterinary students were based in Scotland and studying a Bachelor of Veterinary Medicine and Surgery (BVMS) degree accredited by the Royal College of Veterinary Surgeons, the European Association of Establishments for Veterinary Education and the American Veterinary Medical Association. The BVMS is a 5 year programme. Years 1 & 2 comprise a system-based integrated course with an emphasis on early clinical skills development in simulated (but typically not clinical) settings. Years 3 & 4 focus on clinical training across the major domestic species and disciplines; although the course is primarily lecture-based there is continued emphasis on problem solving and clinical and professional skills development. Students in their final year complete 32 weeks of clinical placements, which include multi-species core and elective opportunities. In common with other UK veterinary schools**,** BVMS students are required to complete 38 weeks of extra mural studies (EMS) over the course of their training. This comprises 12 weeks of preclinical EMS with a focus on animal handling and husbandry followed by 26 weeks of clinical EMS, usually spent in a range of veterinary practice settings. Although self-awareness is promoted through use of a reflective portfolio, the concept of ambiguity tolerance is not explicitly included in the veterinary curriculum

Questionnaire selection

If, as indicated by previous research[8,11] the TAMSAD and TAVS scales act as unidimensional measures of tolerance of ambiguity each individual respondent can be assigned a tolerance of ambiguity score, the mean of which can be compared across populations. One challenge was to determine which scale is best placed to act as the gold standard for comparing ambiguity scores across these populations. In this situation we have four options: 1) the initial full 41 item scale administered to both populations, 2) the 29 item TAMSAD scale validated in the medical student population, 3) the 27 item TAVS scale validated in the veterinary student population, 4) a new scale, hereinafter referred to as the TA22 scale, comprising of the 22 items included in both the TAMSAD and TAVS scale. Table 1 shows the items shared by both scales and those items included in either the TAMSAD or TAVS alone (insert table 1 here).

Given that option 1 would involve using a scale not validated for either population the use of this scale was discounted. There are advantages and disadvantages of using each of the other three scales. While option 4 could be argued to be the most methodologically robust, as it contains only items shared by both other validated scales and has a good internal consistency for both populations, this scale was not developed specifically for this purpose. We have therefore analysed the data utilising options 2, 3 and 4.

Data analysis

We tabulated the profiles of the medical and veterinary student groups with regard to their sex, graduate status on entry to the programme and year of programme. For each of the three scales we calculated a score for each student on a 0-100 scale and, separately for medical and veterinary students, reliability coefficients (Cronbach's Alpha) and the mean and standard deviation of the scale scores. Scores were calculated by transforming the original 1–5 likert scale response to a 0–100 scale using the formula; New score = 25(Old score -1).

We used ANOVAs (Analysis of variance) to compare the mean scores of medical and veterinary students on each scale, controlling for sex, graduate entry, and year of programme.

Local ethics committees at both institutions approved the use of the data for secondary analysis in this way. The processes for gaining participant consent were similar between the two institutions.

Results

Response rate:

The response rates of medical and veterinary students are found in the original papers but have been displayed here to aid interpretation of the new data (insert table 2 here). Only data for the first four years of both programmes are included in this secondary analysis. The response rates of both populations were similar: 62% (232/372) for medical students and 59% (293/504) for veterinary students. Response rates were lower for third and fourth year veterinary students than for other groups.

Validity evidence

When comparing the internal reliabilities of the three different potential scales across the first four years of both populations the reliability of all 3 scales is acceptable for medical students, each with a Cronbach's alpha >0.7. The internal reliability scores are slightly lower for the veterinary student population, particularly when the TAMSAD scale is used (Cronbach's alpha score 0.549). This is important as the internal reliability of the scale, sometimes referred to as the internal structure, forms one component of a validity argument for the use of these scales in this context. Other components of the validity argument, as applied to the medical education context by Downing[13], include: content, response process, relationship to others variables and consequences.

Using each of these domains it is argued in the original TAMSAD paper that this scale is valid for measuring levels of tolerance of ambiguity in medical students. This paper argues that content related validity evidence was provided through the provenance of the items, which were derived from an analysis of the education literature, from medical education theory and from existing tolerance of ambiguity scales. The high internal consistency of the final scale (Cronbach's a = 0.80), and the failure of a factor analysis in identifying any interpretable factors meant that the scale was interpreted as acting as a unidimensional measure of tolerance of ambiguity. It was argued that the findings were broadly consistent with those demonstrated on the subject to date, as in this paper second year postgraduate doctors were found to have higher levels of tolerance of ambiguity than first, third and fourth year medical students. Finally the paper argued that the consequences of completing the questionnaire were minimal[11].

The original validation study with veterinary students makes similar arguments for the validity of the TAVS scale. The argument for content validity is based on the choice of scale items developed from a validated scale used with medical students and modified, where necessary, through minor changes in wording to reflect the veterinary context. The internal consistency of the TAVS scale is acceptable, but not as high as the TAMSAD scale (Cronbach's a = 0.67). Exploratory factor analysis suggests that the TAVS scale can be conceptualised as a unidimensional measure with four discrete facets, however this does not necessarily explain the lower internal consistency, particularly given that other measures with multi-faceted structures are reported to achieve high internal consistencies[14]. It is proposed that the difference in internal reliability between the two scales is most likely to relate to subtle differences in the interpretation of the scale items in the veterinary context.

Each of these validity arguments are set out in more detail in the primary research papers [8,11].

Comparison of medical and veterinary students

After controlling for differences in sex, graduate entry, and year of programme (Table 3) we found differences in tolerance of ambiguity scores for two of the three scales (Table 4). When both the TAVS and the TAMSAD scales were used medical students were found to have statistically significantly higher tolerance of ambiguity scores than veterinary students, however these differences were small with effect sizes (Partial Eta squared) between 0.001 and 0.025 (insert table 4 here). When the TA22 scale was used the difference in tolerance of ambiguity scores between veterinary and medical students was small and did not reach statistical significance.

Discussion

The aim of this study was to compare the tolerance of ambiguity of medical and veterinary students in the UK. Our hypothesis was that veterinary students would have higher tolerance of ambiguity, given the less well established evidence-base underpinning their work and the multiple animal species they care for. However, using the TAMSAD and TAVS scales indicated that medical students had a higher mean score than veterinary students, although no difference was seen between the two groups when only the 22 shared items were considered. This does not support our hypothesis and also highlights that different findings can result when different tools are used.

It is unclear why the difference demonstrated between populations when both the TAMSAD and TAVS were used was not replicated when a 22 item scale, containing only those items found in both other validated scales, was used. One possibility is that the difference between these populations is small and driven more by responses to some items than others. Alternatively, the statistically non-significant difference found when the TA22 scale was used may represent a type 2 error; that is, failing to find a difference when one exists. This could be due to the small sample sizes and the less-than-perfect reliability of the scale.

While it may be too soon to say that medical students have a higher tolerance of ambiguity than veterinary students we could hypothesise that part of the difference detected could be due to the teaching methods used in each setting. While the medical students studied were exposed to a problem based learning curriculum specifically design with increasing students tolerance to ambiguity in mind the veterinary students were enrolled on a case-focussed but primarily lecture-based undergraduate programme.

Similarly, it may reflect characteristics of those attracted to each profession. Tolerance of ambiguity has been associated with postgraduate career choices in one study of medical students[15], although this finding was not repeated in similar studies[16]. It is possible that the choice between veterinary and medical career paths may be influenced by tolerance of ambiguity. For example, the personality traits of extroversion and openness have both been positively correlated with tolerance of ambiguity tolerance[17] and one might hypothesise that extroverts would be more likely to choose a medical career path which they perceive to involve greater social interaction.

This is a complicated area, given that there are many similarities as well as differences between the two professions. Both professions have high academic requirements for admission to study and demanding training programmes, which may be significant given that other personality traits such as perfectionism have been negatively associated with ambiguity tolerance[18] and the fact that students training for both professions have higher rates of mental health morbidity than the general population[19, 20].

What this study does appear to show us is that even quite subtle changes in the items which constitute a scale can produce significant differences in findings of levels of mean tolerance of ambiguity between the two populations. This is important at a time when there is growing interest in using scales such as these to aid in high stakes decision making such entry to medical school[21] and there are an increasing number of scales to choose between.

The different outcomes from each of these scales also indicate that we should exercise caution when using measurement scales and extrapolating research findings from the medical undergraduate population to the veterinary student setting. It remains unclear why different results were obtained when we used subtly different scales however this does demonstrate that there are some challenges with using scales across varying contextual settings. We suggest that this may be due to perceived differences in the meanings or relevance of specific scale items in different contexts and should be considered when research findings and educational theory are extrapolated between medical and veterinary student populations in the future.

Finally we could look at the different items included in each scale and consider if the results suggest that there are differences in the patterns of responses in key areas that can be explored further in future research.

Study limitations

Our study is the first to compare levels of tolerance of ambiguity between the medical and veterinary student population, and one of the first to discuss the benefits and challenges of extrapolating research conducted in the undergraduate medical student population to the undergraduate veterinary student population. Despite this our study does have several weaknesses, the first being that the sample sizes were determined by the fact that the study is a secondary analysis of existing data. Our analyses may therefore lack power to detect real differences between the two populations.

The difference in the internal consistency of measures used within the medical and veterinary student populations highlights the potential for different interpretation of scale items in different contexts. This is supported by our observation that the internal consistency of the TAMSAD scale used with veterinary students was particularly low (Cronbachs a = 0.549). Development of additional scale items specific to the veterinary context, for example through further consultation with practitioners and student groups, could improve both the content validity and reliability of the TAVS scale.

One significant limitation is the relatively low response rates of third year medical students and third and fourth year veterinary students. In the case of medical students one practical limitation was that due to the transition from university based to clinically based placements between years two and three, students were geographically more distributed and therefore harder to reach in later years. In the case of veterinary students, the third and fourth year sampling opportunities were informal (at the end of a teaching session) and students may have been reluctant to participate in this additional survey, particularly where they will already have had to complete a number of course evaluation surveys by this stage in training. There is a possibility that if there is a significant change in levels of tolerance of ambiguity throughout either undergraduate programme that effects one population more than the other, for example due to exposure to different education environments, then a smaller sample size in the later years of study may have had an impact on our findings. Clearly in future research in this field it is crucial to ensure that good response rates are achieved for all levels of undergraduate training in both populations. A further limitation stems from the use of only one veterinary student and one medical student population in the original studies. It is likely that the veterinary student population studied had a much higher proportion of graduate and non-UK citizens than the medical student population. This is interesting as previous research has indicated that older students and graduates are likely to be more tolerant of ambiguity[22], leading us to expect that the veterinary student population would have been more tolerant of ambiguity, which was not the case. As educational programmes vary between institutions, it is difficult to argue that the outcomes of our comparison of the two groups can necessarily be generalised to the broader veterinary and medical student populations and further multi-institution studies will be required in order to do this.

Conclusion

Through comparing the results of different item combinations we have demonstrated that medical students may be more tolerant of ambiguity than veterinary students (two scales) or at least comparable in their tolerance of ambiguity (one scale). While the exact reasons for this are unclear it does demonstrate that subtle changes in the construction of such scales can have a substantial impact on the scale results, which indicates that we should use caution when using such scales to make high stakes decisions, and when extrapolating research findings in the undergraduate medical to veterinary student field.

We suggest that further research is needed to help understand the relationship between levels of tolerance of ambiguity between medical student and veterinary student populations and that to achieve this further multi-institution studies would be required.

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*Table 1: Items contained in TAMSAD and TAVS (wording in brackets represents wording used in veterinary student population, * represents items reverse coded prior to analysis)*

		Item in TAMSAD?	Item in TAVS?
	I would enjoy tailoring treatments to individual patient problems.	Y	Y
	A good clinical teacher is one who challenges your way of looking at clinical problems.	Y	Y
	What we are used to is always preferable to what is unfamiliar.*	Y	Y
	I think in (veterinary) medicine it is important to know exactly what you are talking about at all times.*	Y	Y
	I feel comfortable that in (veterinary) medicine there is often no right or wrong answer.	Y	Y
	A patient with multiple diseases would make a doctor's (vet's) job more interesting.	Y	Y
	I am uncomfortable that a lack of medical (veterinary) knowledge about some diseases means we can't help some patients.*	Y	Y
	The unpredictability of a patient's response to medication would bring welcome complexity to a Doctor's (Vet's) role.	Y	Y
	Being confronted with contradictory evidence in clinical practice makes me feel uncomfortable.*	Y	Y
	I like the mystery that there are some things in (veterinary) medicine we'll never know.	Y	Y
	Variation between individual patients is a frustrating aspect of (veterinary) medicine.*	Y	Y

	I find it frustrating when I can't find the answer to a clinical question.*	Y	Y
	I feel uncomfortable knowing that many of our most important clinical decisions are based upon insufficient information.*	Y	Y
	No matter how complicated the situation, a good Doctor (Vet) will be able to arrive at a yes or no answer.*	Y	Y
	I feel uncomfortable when textbooks or experts are factually incorrect.*	Y	Y
	I like the challenge of being thrown in the deep end with different medical (Veterinary) situations.	Y	Y
	It is more interesting to tackle a complicated clinical problem that to solve a simple one.	Y	Y
	I enjoy the process of working with a complex clinical problem and making it more manageable.	Y	Y
	A good job is one where what is to be done and how it is to be done are always clear.*	Y	Y
	To me, (Veterinary) medicine is black and white.*	Y	Y
	The beauty of (Veterinary) medicine is that it's always evolving and changing.	Y	Y
	I would be comfortable to acknowledge the limits of my (Veterinary) medical knowledge to patients (clients).	y	Y
	I have a lot of respect for Consultants who always come up with a definite answer.	Y	N
	I would be comfortable if a clinical teacher set me a vague assignment or task.	Y	N

	I feel uncomfortable when people claim that something is ‘absolutely certain’ in medicine.	Y	N
	A doctor who leads an even, regular work life with few surprises, really has a lot to be grateful for.	Y	N
	It is important to appear knowledgeable to patients at all times.	Y	N
	I am apprehensive when faced with a new clinical situation or problem.	Y	N
	There is really no such thing as a clinical problem that can’t be solved.	Y	N
	I am comfortable to acknowledge that I’ll never know everything about veterinary medicine.	N	Y
	I think it is important to attribute percentage likelihood to a diagnosis or a specific patient outcome.	N	Y
	‘I don’t know’ are really important words in veterinary medicine.	N	Y
	I enjoy reducing detailed scientific problems to their core concepts.	N	Y
	In Veterinary medicine as in other professions, it is possible to get more done by tackling small, simple problems rather than large and complicated ones.*	N	Y

Table 2: Response rates and mean tolerance of ambiguity scores for medical and veterinary students

Year	Medical student responses	Percentage %	Mean tolerance of ambiguity score (TAMSAD) medical students	Veterinary student responses	Percentage %	Mean tolerance of ambiguity score (TAVS) veterinary students
1	74/110	67	57.11	108/120	90	58.54
2	72/112	64	58.47	114/128	89	57.55
3	34/72	47	56.36	46/128	36	59.02
4	52/78	67	57.72	25/128	20	60.02

Table 3: Sex and study profile of the veterinary and medical student groups (percentages within group)

Factor	Medical students (%)	Veterinary students (%)
Male	44.0	33.2
Graduate entrant to programme	7.4	37.8
Year 1	31.9	37.6
Year 2	31.0	40.1
Year 3	14.7	15.0
Year 4	22.4	7.3

Table 4: Tolerance of ambiguity reliability coefficient and mean scores compared between veterinary and medical students across the TAVS, TAMSAD and TA22 scales

	Veterinary students		Medical students		Comparison		
Scale used	Cronbach's alpha	Mean score (SD)	Cronbach's alpha	Mean score (SD)	Mean difference	P value[4]	Effect size[5]
TA22[1]	0.658	57.2 (7.87)	0.732	56.1 (8.17)	-1.14	0.513	0.001
TAVS[2]	0.669	58.5 (7.34)	0.706	60.4 (7.45)	+1.81	0.002	0.019
TAMSAD[3]	0.549	54.1 (6.36)	0.764	56.1 (8.17)	+1.95	<0.001	0.025

1. 22 items common to the TAMSAD and TAVS scales.
2. 22 items shared with TAMSAD and 5 items unique to TAVS – validated in veterinary student population.
3. 22 items shared with TAVS and 7 items unique to TAMSAD – validated in medical student population.
4. P value from ANOVA
5. Partial Eta squared.