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Misconceptions in the knowledge of vocational fitness students and graduates

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The use of non-academic sources of health information is popular among both the public and exercise professionals. However, the quality of this information varies and without the application of critical thinking skills, may lead to misconceptions forming. This research aimed to compare the knowledge, presence of misconceptions, and critical thinking ability of vocational education and training (VET) fitness students at the beginning and end of their training, and qualified personal trainers (PTs). It also examines differences in the sources of information used by students and professionals. An Exercise Science Knowledge Survey was developed to assess knowledge and misconceptions about ten areas of exercise and nutrition. VET students were assessed at the beginning and end of a personal training qualification and PTs were surveyed once. Though VET students' knowledge improved and misconceptions decreased from pre- to post training, PTs did not differ from post-VET students in knowledge,

misconceptions, or critical thinking ability. PTs reported using more varied sources of information and were more likely to trust reliable sources. Critical thinking ability correlated with higher knowledge scores and lower misconception scores. Instruction in critical thinking should be embedded at lower levels of VET, and exercise professionals should be encouraged to undertake higher levels of study.

Keywords: *critical thinking, personal trainers, sources, professional development*

Introduction

The benefits of physical activity and healthy eating are well established and widely promoted to the public. However, patterns of eating and exercise can vary greatly, so it is not unusual for the public to search for information to inform their decisions. While searching for health information online is popular among the public, (Fox & Duggan, 2013; Hall, Bernhardt, Dodd & Vollrath, 2015), and those accessing websites for health information have a sense of competence and control in making health decisions (Lemire, Sicotte & Paré, 2008), there is a risk of receiving poor quality information. A range of informal sources such as forums and social media may be used (Lederman, Fan, Smith & Chang, 2014), and readers may not investigate the quality of the information presented in detail, instead relying on heuristics to judge the information (Metzger, Flanagin & Medders, 2010). A heuristic approach is a cognitive shortcut, used to reduce complex mental tasks into simple judgements, and speed up processing (Stanovich, Toplak & West, 2008). While often helpful, heuristics can negatively impact learning, as they may affect how new information is interpreted. This information may be judged based on its agreement with existing opinions (Koriat, Lichtenstein & Fischhoff, 1980), known as confirmation bias (Nickerson, 1998). Later evidence inconsistent with this opinion is diminished in importance (Sherman, Zehner, Johnson & Hirt, 1983), and over time the existing opinion can become stronger. If this opinion is incorrect, a misconception can form. This is a persistent belief contradicting current scientific opinion (Badenhorst, Mamede, Hartman & Schmidt, 2015).

Correcting a misconception requires the learner to undergo a process of conceptual change (Posner, Strike, Hewson & Gertzog, 1982). But

this process is more difficult, and the misconception more resistant to change, if the misconception is fundamentally different from the correct understanding. Chi (2005) used two physiological processes to illustrate this point. While circulation is a direct process, with clearly identifiable actions and effects, the process of diffusion is emergent, with a number of actions occurring concurrently, and independently of each other, and as a result, is harder to understand. Chi (2005) proposed that misconceptions can be durable if concepts are interpreted in a different ontological category, such as emergent process misunderstood as a direct process.

Misconceptions related to exercise and nutrition topics may originate from exposure to incorrect information and be strengthened over time as confirmation bias influences the perception of new information. Popular misconceptions in exercise and nutrition include concepts around obesity (Casazza, et al., 2013), protein supplements (Duellman, Lukaszuk, Prawitz & Brandenburg, 2008), vitamins (O'Dea, 2003) and resistance training (Manini, Druger & Ploutz-Snyder, 2005). To correct these misconceptions, Posner et al. (1982) proposed that the learner must become dissatisfied with their current knowledge (otherwise new information is rejected), and a new, convincing, intelligible conception must be available.

Misconceptions in personal trainers

There are over 27 000 exercise professionals registered with the peak body (Fitness Australia, 2016), the majority qualified as personal trainers. While Barnes, Desbrow, and Ball (2016) identified that PTs in Australia report high levels of confidence in their knowledge, they did not assess the actual knowledge of participants. Given that other research has identified significant errors in the knowledge of PTs (Kruseman, Miserez & Kayser, 2008; Malek, Nalbone, Berger & Coburn, 2002; Zenko & Ekkekakis, 2015), that confidence may be misplaced. PTs have also been found to place importance on experience and on-the-job training, over formal qualifications (De Lyon & Cushion, 2013), but research has found that the quality of sources of information PTs use to inform their practice are unrelated to their experience, or level of qualifications (Bennie, Wiesner, van Uffelen, Harvey & Biddle, 2017). A more experienced PT is not necessarily making better choices about sources of information.

Misconceptions have more potential to survive in the face of less reliable information. A meta-analysis by Stacey, Hopkins, Adamo, Shorr, and Prud'homme (2010) examined the sources of information used by PTs, and the barriers to using evidence-based information. Although only two studies met the criteria for inclusion in the meta-analysis, results showed that PTs reported difficulty assessing the quality of information they were presented with. Subsequent research is consistent with this, identifying a large proportion of Australian PTs rely on unreliable sources of information (Bennie et al., 2017; McKean et al., 2015). McKean et al. (2015) identified that the majority of trainers used online sources and magazines as sources of information, in addition to more reliable sources. Systematic reviews have consistently identified that online sources are mixed in quality (Eysenbach, Powell, Kuss & Sa, 2002; Zhang, Sun & Xie, 2015), with many not disclosing information like author details, sponsorships, or source material. Therefore, misconceptions could avoid correction, and even be reinforced. Bennie et al. (2017) attempted to identify factors that predicted the regular use of high-quality information in PTs, assessing age, time as an industry professional, employment status, qualification, the timeframe and mode of learning of their qualification, and industry setting. Of these factors, only age (those over 40 years old) and industry setting (outdoor personal trainers, and those in medium-sized facilities) predicted participants' use of high-quality sources of information.

While PTs in Australia are required to undertake professional development to maintain registration with the peak body, this registration is voluntary, and PTs have a broad scope to select the professional development they participate in. Given the sources of information identified above and the difficulties reported by trainers in identifying the quality of information, PTs could be exposed to very little evidence-based information. Errors in knowledge could, therefore, persist to become enduring misconceptions that are not corrected.

Misconceptions in students

Alternative concepts leading to exercise and nutrition misconceptions can arise, not only from misinterpreting information in instructional contexts (Morton, Doran & MacLaren, 2008) but also due to personal experience. Those without relevant expertise may arrive at a fast, intuitive explanation (Baylor, 2001), leading to a naïve concept that may interfere with further learning. University students have demonstrated misconceptions in

cardiac (Ahopelto, Mikkilä-Erdmann, Olkinuora, & Kääpä, 2011), exercise (Morton, Doran & Maclaren, 2008), and respiratory (Michael et al., 1999) physiology, however, the presence of physiological misconceptions have not been assessed in VET fitness students.

It has been proposed that an appreciation of the level of complexity of physiological systems, and the interaction between these systems, will reduce the presence of misconceptions (Badenhorst, Mamede, Hartman & Schmidt, 2015; Michael, 2007). However, this depth of knowledge is not typically a feature of VET, which assesses students' competence in completing job tasks, rather than the knowledge underpinning these tasks (Gonczi & Hager, 2010). Although it is a requirement of VET to prepare students for higher levels of study, research has shown that students transitioning to university struggle with understanding complex theoretical concepts, academic literacy, and the more independent, less scaffolded learning (Ambrose, Bonne, Chanock, Cunnington, Jardine & Muller, 2013).

Posner et al. (1982) recommended that for a conceptual change to be rational, instructors should develop in students an awareness of their assumptions, the assumptions implicit in scientific theory, and of the epistemological foundations of modern science. A key component of this type of thought is critical thinking ability (CTA), which is defined as reasoned, reflective thinking (Pithers & Soden, 2000). This also encompasses an awareness of the limitations of one's knowledge, and the skills to find, and assess the quality of, new information. Therefore, CTA may be a factor not only in the presence of misconceptions but also the sources of information chosen by students and PTs.

Critical thinking skills have been repeatedly identified as highly desirable by employers (Jackson & Chapman, 2012; Sheldon & Thornthwaite, 2005) but are not a major component of VET. CTA has, however, been found to be strongly associated with student success in United States community colleges (Fong, Kim, Davis, Hoang & Kim, 2017), suggesting it may also play a role in VET. The CTA of VET students before commencing a course, or the change in CTA during a course, has not yet been empirically investigated. There is also no known research on the CTA of PTs.

So, while it is known that the knowledge of PTs is often formed from poor quality sources (Bennie et al., 2017), misconceptions in the understanding of fundamental exercise and nutrition topics (that could

be passed on to their clients) have not been assessed, either in PT or VET students. Whether the CTA of PT and VET students is related to these misconceptions is also unknown. While recent research has examined the sources of knowledge of PTs (Bennie et al., 2017), it is not known if the use of more reliable sources, or trust in these sources, is related to better knowledge, or fewer misconceptions. The aims of this study therefore were, i) to assess the change in knowledge, misconceptions, and CTA during a VET fitness course, and compare these findings in students with VET qualified PTs; ii) to determine whether the presence of misconceptions was related to lower CTA, knowledge, or level of education; and iii) to identify the sources of information used by VET students and PTs, the amount of trust placed in these sources, and whether the use or trust of particular sources was associated with knowledge, CTA, or the presence of misconceptions.

Design

This was a prospective cohort study of students undertaking a vocational fitness course. Students were surveyed in the first weeks of their course, then again in the final week, during February and December 2017. This allowed the change in students during the course to be examined and is in contrast to previous research into the knowledge of students and professionals, which is largely cross-sectional. Practising PTs were also surveyed once within the same period.

Participants

Students completing the vocational qualifications Certificate III in Fitness (SIS30315) and Certificate IV in Fitness (SIS40215) were recruited from three Registered Training Organisations (RTOs) in Perth, Western Australia. SIS30315 contains prerequisite units for SIS40215, so these qualifications are often completed back-to-back to qualify as a PT. One hundred and eleven students enrolled full-time in on-campus (not online) courses were recruited. Sixty-six complete sets of pre- and post-course responses were obtained.

The PT group consisted of 70 Certificate IV qualified personal trainers, currently working in the delivery of exercise programs to adults and registered with Fitness Australia. The demographic characteristics of each group are shown in Table 1.

Table 1: Mean (±SD) group demographic characteristics, including highest educational attainment (AQF level), for VET fitness students and personal trainers

		VET fitness students	Personal trainers
Gender	Male	38 (58%)	39 (56%)
	Female	28 (42%)	31 (44%)
Age in years (SD)		24.15 (8.59)	33.17 (9.81) *
AQF level (SD)		3.42 (1.84)	5.49 (1.82)*
Industry experience (years)			6.10 (5.94)
Exercise AQF level			4.10 (0.30)

* significantly different to VET fitness students ($p < 0.05$)

A power analysis determined that a total sample size of 34 was required to yield an actual power of 0.8 for a paired samples *t*-test to assess differences in the student group pre and post course completion. One hundred and twenty-eight participants were required to yield an actual power of 0.8 for an independent samples *t*-test to assess differences between the student group and personal trainers. Eighty-nine participants were required for a multiple linear regression yielding a power of 0.8, based on six predictors of misconceptions (group, CTA, Australian Qualifications Framework [AQF] level, and trust ratings for three categories of sources of information).

Measures

The Exercise Science Knowledge Survey (ESKS) (Jolley 2019), which consists of a series of 10 misconceptions and 10 knowledge statements, was used to assess participants' endorsement of common misconceptions related to exercise and nutrition. The ESKS was designed following a series of interviews with experienced lecturers from university exercise science departments and vocational fitness courses. Lecturers were asked for their opinions regarding a range of misconceptions based on previous research (Ebben & Jensen, 1998; Kieffer, 2008; Morton, Doran & MacLaren, 2008), and their own professional experiences. Lecturers were also asked to identify how each misconception should be corrected, to inform the knowledge statements in the ESKS which assess the correct understanding of the topic. The items included in the ESKS are shown in Table 2.

Table 2: Misconceptions and knowledge statements included in the Exercise Science Knowledge Survey (ESKS)

Misconceptions	Knowledge statements
Protein is the most crucial nutrient for muscle growth. If you want to get bigger or stronger, the more you can eat, the better	Very large quantities of protein are not necessary to improve your response to training. Your body only uses as much as it needs, extra protein gets broken down and excreted in urine
Gentle, static stretching before exercise is a good way to reduce your risk of getting injured	A gradual, progressive increase in the intensity of exercise is a good way to warm up and prevent injury
An hour of low intensity cardio training will burn more fat than an hour at high intensity. Therefore, you will lose weight faster doing low intensity cardio training	Higher intensity exercise uses more energy than lower intensities. Increased energy expenditure is a key part of successful weight loss programs, so this should be encouraged when safe to do so
If a part of your body is exercised hard, you will lose body fat from that area. For example, stomach crunches will help to flatten your stomach	Fat metabolism is not a local process. You can't pick where you lose body fat from by exercising specific parts of the body
If you want to lose weight, then a short term fast or juice cleanse to flush toxins out of your system is a good way to get things started.	The weight loss result from a short term fast or juice cleanse is usually a result of reduced muscle glycogen storage, and less water retention. This weight will return once the fast finishes
When we exercise hard lactic acid builds up in our muscles. This is the cause of fatigue	You get tired when you exercise at high intensity for several reasons, including (but not limited to): depleted muscle glycogen, accumulated muscle damage, increased acidity in the muscle, and psychological fatigue
A vitamin supplement (like a multivitamin) can improve your well-being, energy levels, and exercise performance	A healthy, balanced diet provides most of the micronutrients you need. Vitamin supplements are unnecessary for most people
A diet high in protein and fats, with little or no dairy or grains, is healthier than what is recommended in the Australian Dietary Guidelines	A healthy diet should be generally consistent with the Australian Dietary Guidelines, contain food from all the major food groups (including grains & dairy), and contain moderate amounts of carbohydrate, fat, and protein
"No pain, no gain." To get stronger or fitter, you need to endure some pain. This is necessary to make your body adapt to exercise	It is possible for most people to get stronger without feeling significant pain. Muscle damage (and resulting pain) is largely caused by eccentric muscle contractions, and you can still get stronger while keeping soreness to a minimum
Women have a risk of getting too muscular if they lift heavy weights. To avoid this, use lighter weights, and perform more repetitions	Most people can lift heavy weights for improved strength and health, and not get too muscular. Women will generally find gaining muscle much harder than men, due to hormonal differences between genders

Participants rate whether they agree with each statement ("yes", "no", or "not sure"), and are instructed not to guess. For each item rated "yes" or "no", participants also rate their confidence in their answer on a three-point scale (1=slightly confident to 3=very confident). A "don't

know" answer to a statement resulted in a confidence score of zero for that item. The ESKS produces a Knowledge score and a Misconceptions score. Knowledge (KNOW) is computed from the number of knowledge statements rated as "yes" (maximum value 10). The Misconceptions (MISC) score is the number of misconception statements agreed with (maximum value 10). Cronbach's alpha for the Knowledge and Misconception scores were 0.64 and 0.77, respectively. Internal consistency coefficients of this magnitude have been considered adequate reliability for cognition and numeracy measures (Liberali, Reyna, Furlan, Stein & Pardo, 2012).

Critical thinking ability (CTA) was assessed using Frederick's (2005) three-item Cognitive Reflection Test (CRT), which requires participants to derive answers to mental arithmetic questions that have deliberative, accurate answers that are usually obtained after considering an incorrect, intuitive answer. The Cronbach's alpha coefficient in the present sample (a = 0.59) was below commonly accepted levels of internal consistency. However, given the CRT only contains three items, and has been shown to predict performance in tests of bias and heuristics (Toplak, West & Stanovich, 2011), and a range of other cognitive skills (Oechssler, Roider & Schmitz, 2009; Pennycook, Cheyne, Seli, Koehler & Fugelsang, 2012), which make up CTA, this was considered acceptable.

Demographic information and highest prior educational attainment (AQF level) were collected, as well as the length of time PTs had worked in the fitness industry, and their highest exercise qualification (Exercise AQF level).

Participants also identified what sources of exercise or nutrition information they had accessed in the previous 12 months from a list of 21 options of varying quality, including professionals, online sources, academic sources, and informal sources (such as friends). Participants also rated the trustworthiness of each source (regardless of whether or not they accessed this source) on a five-point Likert-type scale (1=not at all trustworthy, 5=very trustworthy).

Procedure

Ethics approval was granted by the Curtin University Human Research Ethics Committee (HRE2016-0292). All participants were volunteers,

and informed consent was gained prior to completing the survey. All responses were anonymous, with each participant generating a unique code that allowed matching of pre- and post-course survey data. The pre-course survey (pre-VET) was completed in the first week of the Certificate III, and the post-course survey (post-VET) was completed in the final week of the Certificate IV course. Students were recruited via the RTO delivering their course and surveyed during class time.

Personal trainers (PT) were recruited via convenience snowball sampling using the first author's fitness industry contacts, emails to Australian gyms, and postings on relevant private social media groups.

The survey was completed in person on a provided tablet device, without using reference material, and took approximately 15 minutes.

Data analysis

Data were analysed using SPSS Version 25 (IBM Corporation). Differences between pre-VET and post-VET were assessed using paired samples *t*-tests. Differences between pre-VET and PT, and post-VET and PT groups in Knowledge, Misconceptions, and Critical thinking ability were examined using independent samples *t*-tests. Cohen's *d* effect sizes were calculated to assess the practical significance of the differences between groups.

Pearson's bivariate correlations were used to examine the association between trust scores and Knowledge, Misconceptions, Critical thinking ability, age, and AQF level.

A hierarchical multiple linear regression analysis was used to examine the relationship between prior education, critical thinking ability, knowledge, and sources, and the presence of misconceptions.

Sources of information were combined into broad categories for analysis. Reliable sources (e.g., textbooks, public health promotion campaigns), and sources of mixed or unknown reliability (e.g. friends, social media, alternative health practitioners), were classified according to the categories identified by Bennie et al. (2017). Additional categories for exercise and nutrition professionals (degree qualified professionals, personal trainers, and physiotherapists), and other health professionals (general practitioners and pharmacists) were also established. The trust score for each category was the mean score for items in the category. Use of each source was coded

as either zero (did not access this source in the previous 12 months) or one (did access this source). The mode of each category was used to identify whether a participant was a user of these sources.

A chi-square test for independence was used to examine differences between PT, and VET groups in the sources of information used. Cramér's V was used to measure the strength of the association between participants' group, and the use of sources. McNemar's test was used to assess changes in the use of sources within the VET group. Differences between those using/not using sources were examined using an independent samples t-test. Differences between groups in trust ratings were examined using paired samples t-test (pre-VET & post-VET), and independent samples t-test (PT and both VET groups).

Significance for all tests was accepted at $p < 0.05$.

Results

Dropouts

Forty-five participants surveyed in the pre-VET group did not complete the post-VET survey. Pre-VET results were examined to explore differences between those who repeated the study, and those who did not. Dropouts scored higher in Misconceptions (4.96 ± 1.79 compared to 4.08 ± 1.65) than those who repeated the survey ($t(110) = -2.69$, $p = 0.01$), but there were no significant differences in Knowledge. Dropouts also scored lower in critical thinking ability (0.13 ± 0.40, compared to 0.38 ± 0.74; $t(110) = 2.07$, $p = 0.04$), had achieved a lower AQF level (2.36 ± 1.84, compared to 3.42 ± 1.76; $t(109) = 3.06$, $p = 0.003$) prior to beginning their course, and reported using fewer sources (4.20 ± 3.35, compared to 6.06 ± 4.20; $t(110) = 2.84$, $p = 0.01$), than those who completed the repeated the survey.

Knowledge and Misconceptions

ESKS and critical thinking ability results for the student group are shown in Table 3. Knowledge increased significantly from pre-VET to post-VET, while Misconceptions decreased significantly. Moderate effect sizes were observed in both Knowledge and Misconceptions. Critical thinking ability did not change.

Table 3: Mean (±SD) Critical thinking ability, Knowledge, and Misconception scores for pre-course (pre-VET) and post-course (post-VET) fitness students.

	Pre-VET	Post-VET	*t*	*df*	Effect size (*d*)
Critical thinking ability	0.38 (0.74)	0.42 (0.79)	-0.91	65	0.05
Knowledge	7.05 (2.12)	8.09 (1.50)	-3.86*	65	0.57
Misconceptions	4.08 (1.69)	3.00 (1.57)	5.43*	65	0.66

Results for the PT group compared to the student group are shown in Table 4. Independent samples *t*-tests showed that PT differed to pre-VET in all measures, with effect sizes being large for Knowledge, moderate for Misconceptions, and small for critical thinking ability. No statistically significant differences were seen between PT and post-VET on any measure.

Table 4: Mean (±SD) Critical thinking ability, Knowledge, and Misconception scores for personal trainers (PT), and comparison to pre-VET and post-VET students.

		pre-VET			post-VET		
	PT	*t*	*df*	Effect size (*d*)	*t*	*df*	Effect size (*d*)
Critical thinking ability	0.69 (0.92)	-2.13*	134	0.37	-1.77	134	0.31
Knowledge	8.56 (1.44)	-4.88*	134	0.82	-1.85	134	0.32
Misconceptions	2.94 (1.63)	4.03*	134	0.69	0.21	134	0.04

In the PT group, the exercise AQF of personal trainers did not correlate with Knowledge (r = 0.10 p = 0.42), or Misconceptions (r = -0.17, p = 0.17). Years of industry experience also showed no association with Knowledge (r = -0.10, p = 0.40), or Misconceptions (r = -0.02, p = 0.90).

Correlations between ESKS scores, critical thinking ability, AQF level, and age for the combined pre-VET and PT are shown in Table 5. Post-VET responses were excluded from this analysis, as these are repeated measures. Age, AQF level, and Critical thinking ability each correlated with Knowledge, and Misconceptions.

Table 5: Correlation between study variables in pre-VET students and PTs.

					Sources				
	AQF	CTA	KNOW	MISC	DQP	OTH	REL	MIX	N
AQF		0.26**	0.21*	-0.26**	-0.16	-0.20*	0.20*	-0.27**	0.16
CTA	0.26**		0.21*	-0.18*	-0.20*	-0.19*	0.10	-0.26**	0.19*
KNOW	0.21*	0.21*		-0.08	-0.04	0.01	0.30**	-0.23**	0.25**
MISC	-0.26*	-0.18*	-0.09		0.23**	0.15	-0.19*	0.29**	-0.08
DQP	-0.16	-0.20*	-0.04	0.23**		0.48**	0.30**	0.39**	-0.08
OTH	-0.20*	-0.19*	0.01	0.15	0.48**		0.28**	0.43**	-0.07
REL	0.20*	0.10	0.30**	-0.19*	0.30**	0.28**		0.13	0.16
MIX	-0.27**	-0.26**	-0.23**	0.29**	0.39**	0.43**	0.13		-0.10
NO.	0.16	0.19*	0.25**	-0.08	-0.08	-0.07	0.16	-0.10	

Critical thinking ability (CTA), Knowledge (KNOW), and Misconceptions (MISC), trust in categories of sources (degree qualified professionals [DQP], other professionals [OTH], reliable [REL], mixed/unknown reliability [MIX], and number of sources [NO])
* $p < 0.05$. ** $p < 0.01$.

A hierarchical multiple regression was conducted to predict Misconceptions scores based on participants' group (pre-VET or PT), AQF level, critical thinking ability, and trust in three of the four categories of sources of information (DQP, REL, and MIX) (see Table 6). Together the set of variables accounted for 20% of total variance in Misconceptions scores ($F(6, 135) = 5.25$, $p = 0.00$), with an R^2 of .20. Significant independent predictors were participants' group (p = 0.00), trust in reliable sources ($p = 0.01$), and trust in sources of mixed or unknown reliability ($p = .04$). AQF level and critical thinking ability did not significantly predict Misconceptions.

Table 6: Hierarchical multiple linear regression analysis predicting Misconception scores

Predictor	*B* [95% CI]	*β*	ΔR^2
Block 1			0.108**
Group	-0.57 (-0.84 - -0.29)**	-0.33	
Block 2			0.013
Group	-0.46 (-0.78 - -0.14)*	-0.26	
AQF level	-0.11 (-0.26 - 0.04)	-0.13	
Block 3			0.011
Group	-0.44 (-0.76 - -0.12)*	-0.26	
AQF level	-0.09 (-0.24 - 0.07)	-0.11	
Critical thinking ability	-0.22 (-0.56 - 0.12)	-0.11	
Block 4			0.065*
Group	-0.13 (-0.50 - 0.25)	-0.07	
AQF level	-0.07 (-0.22 - 0.08)	-0.09	
Critical thinking ability	-0.08 (-0.42 - 0.26)	-0.04	
Trust in degree qualified professionals	0.46 (-0.06 - 0.98)	0.18	
Trust in reliable sources	-0.64 (-1.14 - -0.15)*	-0.24	
Trust in sources of mixed/unknown reliability	0.55 (0.15 - 1.08)*	0.19	

* $p < 0.05$. ** $p < 0.001$

Sources of Information

Almost all participants reported having searched for exercise or nutrition information in the last 12 months (pre-VET 95%, post-VET, 97%, PT 96%). However, independent samples *t*-tests determined that the number of sources (pre-VET 6.06 ± 3.35 sources, post-VET 6.32 ± 3.54, PT 8.69 ± 3.98) used by PTs differed significantly to both pre-VET ($t(134) = 4.156$, $p = 0.00$) and post-VET ($t(134) = 3.662$, $p = 0.00$) groups, with moderate effect sizes for both ($d = 0.71$, and $d = 0.63$, respectively). A paired samples *t*-test showed no significant differences between pre- and post-VET groups ($t(65) = 0.66$, $p = 0.51$, $d = 0.08$). The total number of sources used did not correlate with any other variables.

The use, and trust, of sources in each group, are described in Table 7. McNemar's test revealed no significant differences from expected values in the use of any source from pre-VET and post-VET. Trust in other health professionals increased from pre-VET to post-VET ($t(65) = -2.45$, $p = .02$, $d = 0.32$), and trust in sources of mixed and unknown reliability decreased ($t(65) = 3.37$, $p = .001$, $d = 0.44$).

Comparison of PTs to pre-VET students showed observed counts significantly higher than expected for the use of exercise and nutrition professionals (χ^2 (1) = 10.55, $p = .001$, $V = 0.28$), and reliable sources (χ^2 (1) = 30.49, $p = .00$, $V = 0.47$). Personal trainers also had significantly more trust in reliable sources ($t(134) = -2.23$, $p = .03$, $d = 0.38$), and less trust in all other sources (PRO: $t(134) = 5.80$, $p = .00$, $d = 1.00$, OTH: $t(134) = 4.01$, $p = .00$, $d = 0.69$, MIX: $t(134) = 5.56$, $p = .00$, $d = 0.95$), with moderate or large effect sizes. Comparison to post-VET students similarly showed personal trainers had higher than expected counts for the use of exercise and nutrition professionals (χ^2 (1) = 10.55, $p = .001$, $V = 0.28$), and reliable sources (χ^2 (1) = 21.14, $p = .00$, $V = 0.39$). Trust was in reliable sources was not significantly different ($t(134) = -1.55$, p = .12), and less in all other sources (PRO: $t(134) = 5.24$, $p = .00$, $d = 0.90$, OTH: $t(134) = 5.54$, $p = .00$, $d = 0.95$, MIX: $t(134) = 3.59$, $p = .00$, $d = 0.61$), again with moderate or large effect sizes.

Table 7: Percentage of participants pre-course (pre-VET) and post-course (post-VET) vocational students, and personal trainers (PT) accessing each source, and mean (±SD) trust in each source.

	Pre-VET		Post-VET		PT	
	Use (%)	Trust	Use (%)	Trust	Use (%)	Trust
Exercise & nutrition professionals	37.87	4.18 (0.56)	37.87	4.11 (0.53)	65.71*	3.59* (0.62)
Other health professionals	0	3.78* (0.85)	1.75	4.06* (0.92)	5.56	3.13* (1.03)
Reliable sources	6.06	3.49 (0.66)	12.12	3.55 (0.77)	48.57*	3.73** (0.59)
Mixed/unknown reliability	15.15	2.94* (0.47)	16.67	2.74* (0.43)	28.57	2.42* (0.61)

* significantly different to all other groups ($p < .05$). ** significantly different to pre-VET only ($p < 0.05$)

Discussion

This study examined the knowledge, misconceptions and CTA in VET students and PTs, whether misconceptions were associated with critical thinking ability, education or knowledge, and identified predictors of misconceptions. It also investigated the sources of information used by students and personal trainers, the trust placed in these sources, and whether they were associated with knowledge or the presence of misconceptions. Students were demonstrated to possess misconceptions before entering a VET fitness course. These were partially corrected during the course, as Knowledge improved, and Misconceptions declined. However, there was no difference observed between PTs and students who completed the course, regardless of the experience of the trainer.

The increase in Knowledge during the course was expected. While previous research has identified that PTs performed poorly in assessments of required knowledge (Malek et al., 2002; Zenko & Ekkekakis, 2015), more difficult survey questions could account for this. The statements in the ESKS were largely simple enough for the public to answer correctly, and some misconception statements contained obvious flaws in reasoning. However, the lack of differences in between post-VET and PT groups provides some support for the findings of previous research (e.g., De Lyon & Cushion, 2013; Kruseman et al., 2008), suggesting that the professional development of personal trainers was largely informal and insufficient.

No relationship between Knowledge and Misconceptions was identified in the present study. Further, overall AQF level was associated with fewer misconceptions, while exercise AQF level was not. These findings suggest that misconceptions are not just the absence of knowledge and can co-exist with correct knowledge within the same domain. Furthermore, it appears that generic education and critical thinking ability are important factors in influencing misconceptions. This is consistent with Hughes et al.'s (2015) finding that misconceptions in psychology students were not related to the number of psychology units completed but did relate to time at university. Instruction in critical thinking skills may lead to greater success correcting exercise and nutrition misconceptions than merely providing specific information.

There was no significant change in CTA observed in VET students, although the previous education level of participants was correlated with CTA, also consistent with the findings of Hughes, et al. (2015). Additionally, the CRT scores observed were notably lower than previous research. The mean for PTs (the best performing group) in the present study was 0.69 ± 0.92, whereas other research using the CRT demonstrates a range of scores from 0.7 ± 0.93 (Toplak, West, & Stanovich, 2011) to 2.45 ± 0.64 (Alter, Oppenheimer, Epley & Eyre, 2007). These findings suggest that critical thinking skills are not well developed during a VET fitness course. There are some units in the Certificate IV training package (SIS40215) that require students to analyse health information, demonstrate evaluation skills, and maintain knowledge through independent study. But it has been proposed that teaching critical thinking is a complex, specialised skill, as it requires knowledge of not only critical thinking, but how to contextualise this within the course content, and the pedagogical skills to teach it effectively (Ab Kadir, 2017). Given the limitations of the teaching qualifications of VET lecturers (Guthrie & Jones, 2017), it is not clear they possess the skills to effectively deliver critical thinking instruction. While students are assessed as competent for these skills, the quality of the instruction, and assessment, of these skills is unknown.

From pre-VET to post-VET to PT an increase in the number of sources of information used was observed, with increased use of reliable sources, and exercise and nutrition professionals. Further, trust in all sources, except reliable sources, decreased. Fewer than half of PTs used reliable sources of information, consistent with Bennie et al. (2017), though

those that did scored higher in Knowledge. Since Stacey et al. (2010) highlighted the lack of research on the sources of information of PTs, this has been a growing area of interest. The variety of sources identified here supports earlier qualitative findings (De Lyon & Cushion, 2013) that informal and self-directed learning was an important source of knowledge for PTs. But while Stacey et al. (2010) identified that personal trainers were not confident in assessing the quality of information, those interviewed by De Lyon and Cushion (2013) did not express the same reservations. The differences in trust between VET students and PTs in the present study suggest that PTs can differentiate between reliable and unreliable sources, though the high number of different sources used by personal trainers suggests that this may not inform decisions about which sources to access.

The use of online sources has been a theme in recent research (Bennie et al., 2017, De Lyon and Cushion, 2013), and was a consistently popular source of information in the mixed and unknown reliability category of the present study. But the quality of health information from online sources is highly variable (Eysenbach et al., 2002; Miles, Petrie & Steel, 2000; Zhang, Sun & Xie, 2015), and users have been shown to rely on heuristics to assess the quality of the information they are presented with, using strategies such as endorsements from others, and the extent a site conforms to expectations, to make decisions about trustworthiness (Metzger et al., 2010). It is highly likely PTs will rely on similar strategies to inform their decisions, so it is plausible that misconceptions are reinforced by poor choices of online content.

Given the likely use of these heuristics, and given that Misconception scores did not relate to the exercise qualification achieved by the PT group, it is likely that generic critical thinking skills, such as research skills, the ability to interpret and evaluate claims, and introspection, are required to correct misconceptions. Furthermore, these skills have been repeatedly recognised as being highly desired by employers (Jackson & Chapman, 2012). Improving the depth of knowledge has also been identified as a way to prevent misconceptions (Badenhorst et al., 2015; Michael, 2007), but neither of these approaches to correcting misconceptions is characteristic of VET, which is largely competency-based.

Therefore, improved CTA may allow vocationally qualified PTs to improve their knowledge beyond what is developed during their VET

courses. Given the limitations of VET identified above, the lack of significant differences between post-VET and PT groups, and the lack of an effect from years of experience, it appears that there might be a need for explicit instruction in critical thinking, using domain specific content (Tiruneh, Veburgh & Elen, 2014), to allow PTs to choose appropriate sources of information. As the SIS40215 training package has simple critical thinking skills embedded in it already, attention should be paid to the pedagogical skills of VET lecturers to teach and assess these critical thinking skills. This could be achieved through modification of the Certificate IV in Workplace Training and Assessment or encouraging further study in education in VET lecturers. Further exposure to these skills for personal trainers should be obtained through specially designed professional development resources.

Limitations

There are some limitations to the present study which need to be considered when interpreting these results, and for informing future research. Assessing the impact of a vocational fitness course on professional practice is challenging due to frequent changes to the training package (major updates having occurred in 2000, 2004, 2011, and 2015). This means any sample of PTs is likely to include a variety of training packages, as well as different modes of delivery of training. Additionally, rapidly changing trends in fitness lead to popular misconceptions changing over time, so the misconceptions examined need to be regularly updated. This will make comparing research findings difficult, even when the same survey tool is used.

Although participants were instructed not to guess while completing the ESKS, Knowledge scores may over-estimate the knowledge of those surveyed, as participants may have decided to agree with statements that seemed plausible. For a more detailed assessment of knowledge, multiple choice or short answer questions may be required. Additionally, the reliability of the Knowledge subscale of the ESKS was not sufficient in the present sample. The Spearman-Brown formula indicated that expanding the Knowledge subscale to 15 items would result in a Cronbach's alpha of 0.72. This should be addressed for future use of this survey.

Conclusions

This study has shown that generic critical thinking skills are more important than industry experience or exercise qualifications as predictors of knowledge and misconceptions in practising trainers. PTs should be encouraged to pursue high level (diploma or degree) qualifications where possible to increase their exposure to these skills. There is also a need to further embed these skills into the current Certificate IV in Fitness course, as it appears that these skills are not being developed to a level that allows PTs to manage their professional development, or to accurately assess information on their own. But as VET trainers may lack the skills to teach these skills adequately, critical thinking and relevant pedagogical skills should also be developed further in VET trainers.

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