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Systematic review of the bioecological theory in sport sciences

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Keywords

sport, context, ecology, human development

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Systematic review of the bioecological theory in sport sciences

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Abstract

The purpose of the present review was to provide an up-to-date summary of the bio ecological theory in sport literature. Systematic reviews can facilitate decision-making in areas where randomized control trials (RCTs) have not been performed or are inappropriate. In order to appreciate the status of current knowledge and understanding and to identify potential future directions, the authors conducted a synthesis of published work in sports science using a systematic-review methodology. Published since 1977, Bronfenbrenner's model of human development provided an ecological lens for identifying and synthesizing barriers to sport participation. From a search of electronic databases, findings comprised 1120 identified records, from which only 896 entries were considered. From these a total of 183 published studies relating to the bioecological theory and sports science were assessed, and from this point only articles pertaining to sport related issues were taken into consideration (n = 89) excluding other types of documents (n = 94). The Systematic Review (SR) develops upon these 89 articles and a total of 23 articles were selected for the fourth and final retrieval. A semi quantitative review protocol and standard quality assessment criteria have dominated the research. The authors conclude by summarizing the key findings in the literature and highlighting the gaps that could be filled by future research.

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Introduction

Human development model must be understood as a cultural process, and this understanding requires a historical perspective of individual contribution in community dynamics [1], it will always be in accordance with action significant meanings, different levels of the same social organization and comprehension of particular situations.

As a precursor of developmental psychology, Bronfenbrenner's ecological perspective has contributed important ideas and research on cultural aspects of human development raising questions about treating individual and cultural processes as separate entities. In many studies [2, 3, 4, 5, 6, 7] he illustrated his ideas with studies of other research colleagues. Bronfenbrenner was influenced by the systems theory in biology, emphasizing interaction, change and stability over the lifespan. He was unhappy with the dominant trend in the field of psychology, based on viewing the individual and the environment as dichotomous entities whose influences on development could be examined separately [8].

Bronfenbrenner's theory has suffered successive changes since its first design over half a century ago in the 1950's. A second systemization of Bronfenbrenner's theory [9] and successive reformulations [3, 6, 7, 10] extended and critically revised the original model. In the 1990' the theory began to consider the proximal processes as a significant phenomenon of development [11]. The PPCT model tries to explain why nature, power, content of proximal processes vary systematically in function of personal characteristics in development, context where processes meet and changes that occur over a period of time where processes are occurring [12, 11].

In Brazil, Krebs [13, 12, 11] and Koller [14] have been in the forefront of human ecology development. Bioecological theory has been appropriately used in intervention studies in underserved youth in local deprived communities, integrating theoretical knowledge of human development and public policies. Tudge et al. [15] proceeded with the only review found in the literature. They were able to locate 25 published studies that met the inclusive criteria. From these 25 studies, they found only four [16, 17, 18, 19] in which the authors based their research on Bioecological theory, presenting the theory in its mature form and testing theoretical assumptions through appropriate research designs, using at least three of the Person-proximal Processes-Context-Time model (PPCT) concepts, including proximal processes. After a review of key elements of the development of Bronfenbrenner's work, current research on sport science and knowledge is discussed as embodying many of the core elements of systems theory.

Background to theoretical conceptualizations of Bronfenbrenner in sport

In recent years the use of the Bioecological Theory in youth sport studies is more and more accepted among scholars [20, 21, 22, 23, 24, 25, 26]. In fact, a key point in studying ecological perspectives is that cognitive activity cannot be defined, studied, perceived or interpreted without references to the environment [21]. Recent studies have pointed out multiple-level organizational recognitions as well as contextual influences in adolescent development [27, 28, 29].

Bronfenbrenner [7] considers the joint interaction (i.e., the process) of the person with the environment over different timescales. This aspect helps in the search for environmental variables at different levels of analysis (micro-, meso-, exo- and macrosystems). Focusing specifically on physical activity settings for example [30, 31], the ecological theory provided evidence that the context in which physical activity participation takes place is critically important.

An important characteristic of the model is its interdisciplinary and its integrative focus on youth as well as policies and programs for enhancing youth development. Some reviews are based upon and have picked up on some general ideas of Bronfenbrenner's framework highlighting the interaction between a person's environment and their developmental status applied to sport outcomes [32, 26].

LaVoi and Dutove [26] wrote a recent review on barriers and supports for female coaches, pointing to complex and multidimensional barriers that affect, impede or prevent females from seeking or remaining in coaching positions. Another review highlights current directions in two areas of social influence and interrelationships in sport: peers and parents, they have been found to have a significant impact on psychosocial outcomes in sport [33]. Concomitantly, Limstrand [34]

also proceeded with a review of 239 independent samples located in 43 studies, primarily from the field of public health, environmental characteristics relevant to young people's use of sports facilities.

Although several book chapters have been written in diverse areas that provide more recent summary overviews of research in sport settings, a special issue of the *International Journal of Sport Psychology* paid attention to different ecological approaches to sport cognition. The call for evidence synthesis on this topic is mandatory where a gap in knowledge has been identified as well as prioritized. The purpose of the current study therefore was to conduct a systematic review of bioecological systems in sport science. This review, furthermore, differs from a number of published systematic reviews in that a single research question was not defined a priori. The author's will try to answer two main questions: How does the theory been interpreted through the years in the field of sport? Also, how real life sport situations (practical applicability) have been verified and consubstantiated using this theoretical framework? A review to assess the effects of context and interpersonal relationships on sport participation was undertaken by 2 main objectives:

- Determining how the theory informs of past and current research on sport sciences
- Determining the relatedness between the theory and practical implications of research in the field of sport.

Material and methods

An initial scoping exercise was undertaken prior to the main review. The first three stages of the main review (searching the research literature, assessing the studies which met the inclusion criteria through PICOS (Population Intervention, Comparators, Outcomes and Study Design) review protocol and descriptive quantitative analysis) followed the standard methodologies used in Systematic Reviews (SR) of quantitative studies. The descriptive quantitative analysis consisted of counting each characteristic in a pre-determined category (for example, the category sample size the authors created several items to better fit the data: "less than 20"; "20-50", etc.). Each item (characteristic) had a K number that consisted of the counting articles that fitted the item divided by the total number of articles found in that category. Furthermore, PICOS was initially designed to focus clinical questions and to prompt for publication type or type of question asked, it is a specialized framework to form the question and facilitate the literature search. The final stage of the SR involved a quality assessment and integration of articles based on bioecological systems and sport science.

Sources

Before undertaking SR it was necessary to check whether there were already existing or ongoing reviews, and whether a new review was justified. This process begun by searching SCIRUS, allowing researchers to search not only for journal content but also 'scientists' homepages, and website information. The Scientific Electronic Library Online (SciELO), the Cochrane Database of Systematic Reviews (CDSR) and Campbell Library of Systematic Reviews gave the researchers full details of completed and ongoing systematic reviews.

The search strategy used the following three main sources to locate published studies of Bronfenbrenners' ecology theory in sporting contexts: (a) electronic searches of computerized databases, including dedicated databases such as Elsevier, Science Direct and Psych INFO, were also used. The European Database of Sport Science (EDSS) allowed a thorough search on sport science; (b) citations in papers identified by electronic searches; and (c) hand searching of journals. Limiting searches to English language papers could introduce language bias; therefore, large bibliographic databases were used, such as Google Scholars, Medline and PubMed, do include a small number of non-English language journals.

Procedure

The review protocol was designed to elaborate on the decisions about the review question; inclusion criteria, search strategy, study selection, data extraction, quality assessment and data synthesis were also addressed. Studies included in the review were screened for quality, so that

the findings of a large number of studies could be combined. The review was limited to studies that were directly related to sport participation, perceptions and experiences and based upon Bioecological framework, that serve relevant target populations and that measure at least one outcome of interest. Hard copies of publications were obtained and assessed for relevance according to the inclusion criteria. Checking the synthesis with authors of primary studies was established in order to assess the robustness of the SR as well as ongoing critical reflection on the synthesis process.

Peer review was a key part of the process; qualified independent researchers controlled the author's methods and results. Procedures were explicitly defined in advance, in order to ensure that the exercise is transparent and can be replicated and designed to minimize bias. This kind of analysis has some inherent bias, it is important to assess the likely impact of researchers' personal characteristics (such as age, sex and professional status) and the methods used on the data obtained. Attempts to minimize the introduction of bias included 'weighing' the findings of studies according to technical quality (i.e. giving greater credence to the findings of more methodologically sound studies) and providing a clear justification for this. In fact, in order to reduce language bias the literature review was not confined to the English language but also included Portuguese and Spanish as mentioned earlier.

Analysis

This study followed a strict inclusion/exclusion criteria based on language parameters, location, time frame, population and outcome. There were, however, a number of difficulties in applying the inclusion/exclusion criteria to qualitative research in relation to identifying retrospective data and in determining study type and analysis (whether qualitative data collection and analyses were undertaken). Complementary tables that further illustrate the whole SR process are not shown due to page limits but can be assessed upon reader's request.

For further analysis the author's only accepted articles published in periodic journals and excluded other publication formats like books, book chapters, thesis, articles in German language, implemented programs and articles relating physical activity and leisure and Bioecological theory.

The database search generated a total of 1063 citations which were scanned for possible retrieval, for example, articles with a primary focus on sporting context, dated from 1990-2013 and based upon bioecological systems were selected for the final quality assessment. Only articles after 1990 were assessed because the authors considered that major developments on the theory, namely, a shift of importance towards proximal processes were discussed by that time. Despite this initial reasoning, and assuming that important theoretical considerations about Proximal Processes and Person were only developed in the late 90's, the authors found only two articles dated from the the 90's that deserved some attention for the initial quantitative analysis. So, these criteria were agreed upon and addressed by both authors during the review. Discrepancies were discussed until agreement was reached and consensus was obtained. During the PICOS analysis the co-author reviewed each ecological placement and each outcomes and variables of each study. Again, where discrepancies were found, they were collectively discussed to consensus, resulting in minor modifications.

Data tables were analyzed to create summary tables, which involved a number of stages. First, studies that fitted the SR were included on a literature review table that represented demographic and descriptive generic information such as authors, year, title and journal. Second, a review protocol and PICOS elements was established and another table was elaborated upon the first summarized one.

Each included study was assigned an objective assessment of methodological quality preferably using a method conforming to the current guideline of PRISMA. A flow diagram adapted from Moher et al. [35] served as an evidence-based minimum set of items helping researchers to report a wide array of assessed documents. In the third phase, studies were initially coded with a bibliographic number, but as independent sample populations (k) were used as a unit of analysis. Data tables were constructed for sample characteristics of study populations (e.g. nationality), type of sport, competitive level, and research design.

All documents in the fourth stage and the final selection (n = 23) were thoroughly read and reviewed and evaluated through a scoring system for both quantitative (n = 21) and qualitative (n = 2) studies. Given the lack of a standard, empirically grounded quality assessment tool suitable for use with a variety of study designs, the researchers followed up on Kmet et al. [36] pragmatic systematic review tool “QualSyst” which incorporates two scoring systems to evaluate the quality of the studies potentially eligible for inclusion in our review: one for quantitative research reports, and one for qualitative research reports. This scoring system draws upon existing published tools, relying particularly upon the instruments developed by Cho et al. [37] and Timmer et al. [38] for quantitative studies, and the guidelines suggested by Mays and Pope [39] and Popay et al. [40] for qualitative studies.

Results

General findings

The database search generated a total of 1063 citations which were scanned for possible retrieval; 896 studies were assessed and 186 were retrieved and reviewed. For this reason from a starting pool of 186 documents, 89 articles were assessed for final eligibility and 94 documents excluded with reasons, although they were included and treated as sourceful elements of information. Articles related to physical activity and leisure (n = 29); academic thesis (n = 37); book chapters (n = 15); other languages (n = 3); implemented programs (n = 3) and articles excluded with non-eligible criteria (n = 7) were excluded from the final stage. Therefore, 23 published articles with full eligibility criteria were identified and as stated earlier, the researchers preferably considered two scoring systems to quality assess and synthesize the findings.

Two studies [23, 24] reported findings for both elite and club level. Although these studies have been incorporated only once in the total count of the selected studies (n = 89), they are included in the total counts for club (n = 17) and elite studies (n = 22) because they present separate data relating to each population group.

Bioecological systems in sport science research summary

The examination of sample characteristics enabled us to gain a picture of the types of individuals who have been investigated in research and potential gaps in sampling. Studies examined a total population size of around 28,516 and 89 independent samples were identified. The review articles that analyzed at least one outcome variable were also included distinctively in each category. Only 22 articles from a pool of 89 were eligible for the final stage in quality assessment which means that most research was done with little understanding of the main concepts and propositions. When considering the sample size, one observes that the smallest samples (less than 20, k = 15) and bigger samples (301+, k = 18) are dominant. Samples tend to be mix gender (k = 42) and include athletes from a range of competitive levels and sports with slight attention given to team sports (k = 15). The vast majority of studies were done with elite athletes (k = 22) although a very significant number of studies (k = 20) were made with college sports. North American samples have historically dominated the literature, but, more recently, especially in the last three years, Europe has begun to emerge.

One important gap in the literature is the lack of longitudinal studies (k = 11), only recently [22, 23, 24] this has been addressed with some concern. Qualitative design studies are predominant among the literature and, on the other hand, a mixed approach was only found in two studies [41, 42]. The former emphasizes the effects of sport club activities on adolescent development in Germany, while the latter addresses sport participation among females from adolescence to adulthood.

Quality assessment of bioecological systems based articles

From the final quality assessment arose 22 articles, both qualitative (n = 20) and quantitative studies (n = 2). These articles were selected because they were explicitly based upon Bronfenbrenner's theoretical framework. As a first remark, the majority of studies underwent a qualitative approach, showing that there is still a need to further elaborate on the quantitative design.

Demographic and quantitative analysis

Most of the 22 studies (Tables 1 and 2 in Annexes) are original research articles ($n = 14$) and eight are reviews. From the total amount of selected studies only two are quantitative in their approach and the rest are qualitative ($n = 20$). As stated earlier, these review articles were considered for the final assessment because they fit the inclusion criteria, i.e. they have to be based on bioecological systems and have at least one outcome measure.

The researchers concluded from the findings that there is no dominant research theme through which bioecological systems is applied. Examining the literature reviews and regarding children and adolescents' sport participation, one study relates to dynamic relations between parents' behaviors and children's motivational beliefs in sports and music; another study stresses the environmental characteristics relevant to young people's use of sports facilities [34]; the last one focuses on the mechanisms that give rise to the complexity of children's development in sport [43].

Talent development and bioecological systems ($n = 4$) has been a consistent line of research. In fact, it seems to be a growing interest in the pathway to elite sport. One interesting and a considerable point of reflection is the fact that bioecological systems is used as a useful theory to study interrelationships in sport, describing processes of participation of different actors such as parents, coaches, peers in different ecologies of practice, high school, academy and club.

Quantitative studies are a less common approach to studying bioecological systems in the sports domain. Because they were only two, a brief description of measure and methodology follows. One study aimed to analyze an adolescent's disposition for sports [44]. The design of this study included two contexts (microsystems) with different environmental characteristics: (a) public school and (b) private school, both located in downtown Florianopolis. The results were organized according to two variables of the study: personal attributes (male or female) and context (public or private management). Moore et al. [45] highlight a study which used an ecological perspective to explore and identify various risk and protective factors that might influence sexual activity in adolescence and emerging adulthood, with a particular emphasis on the unique experiences of athletes. Factors at the individual, familial, and extrafamilial level were found to affect sexual activity.

The majority of these selected studies are recent research prior to 2008 ($n = 11$) and focus on a small sample size, less than 20 ($n = 7$). La Voi and Dutove's [26] research on female coaches had a sample size between 50 and 100, integrating barriers and supports represented in the literature organized from most proximal (individual) to most distal (socio-cultural) to the coach. A bigger study (more than 300 individuals) by Pope and O'Sullivan [46] focused on the ecology of "free gym" as it occurred in both school lunch hour and after-school community settings.

Being male oriented studies a current trend, team sports is the main type of sport present in the studies ($n = 7$), the main sport was football at elite level ($n = 7$). In terms of the method design, the cross sectional/qualitative design ($n = 8$) was the most frequently applied, the longitudinal/qualitative approaches ($n = 3$) are recent and insufficient and mostly carried out in Portugal [22, 23, 24]. The only qualitative cross-sectional studies were carried out by Krebs et al. [44] and Moore et al. [45]. There is a clear need for more research in the future using this particular design.

Discussion

Bronfenbrenner's bioecological system is presented as a useful framework for integrating knowledge and for opening new pathways as researchers strive to expand what they already know in sport psychology with a developmental focus [30]. In fact, the theory presents useful to a more applied research focus with a more relevant contextual and interaction approach. Only 7 studies of the 22 eligible scored more than 15 points and were considered the most representative of Bronfenbrenner's theoretical framework. In fact, the great majority of studies ($n = 67$) focused their attention on an incomplete assumption of what the whole theory represents and predominantly disregard the late rebuilds of his theory focusing mostly on the context and on the first draft of the theory [9]. Most of the studies included in the third phase of the synthesis represented a misleading and little understanding of what the theory represents.

In fact, conceptual incoherence is likely to result when studies as the ones screened in the initial 183 records described themselves as being partially based on Bronfenbrenner's theory. The majority of these studies in recent years have cited his initial conceptualization, ideas taken from the 1970s or 1980s and others from the 1990s. Simplistic presentations of Bronfenbrenner's ecological systems theory focus on its attention to context [47]. Bronfenbrenner's first model [9] was centered on the role of the environment in shaping development. Regarding these studies capacity to connect to the theoretical framework and a wider body of knowledge, the context is not adequately well described, not permitting to relate the findings to other settings.

Although this accurately represents the first phase of Bronfenbrenner's work, it is argued that the core feature of Bronfenbrenner's later work is its attention to the patterning and interrelationship of multiple determinants of development and on the active role of the developing person. The full theory in its developed form deals with interrelations among the following four PPCT concepts later developed as a theoretical structure of proximal processes proposed by Krebs [13]. The inclusion of the three properties of the person, biopsychological resources, directional disposition, and demands; the dimensions of time; and the characteristics of proximal processes, may be viewed as a turning point in his theoretical framework [12].

An important question to address is to how one can distinguish the influence of proximal processes from those of the microsystem, the microtime, or the person, and how can a researcher trace these influences? Krebs [11] points out the necessity to examine the influence of the proximal process by controlling the interaction between the three other elements. This procedure was best illustrated with Domingues and Gonçalves[24], La Voi and Dutove[26] and Holt et al. [32] as they were able to demonstrate the interaction between factors.

Researchers in the present study have not found any study with a quantitative longitudinal design as well as a mixed method approach. Considering the fact that only two studies were quantitative in nature reveals some difficulty in finding measurements to assess quantitatively the operational concepts that bioecological systems addresses, especially what Bronfenbrenner considers the engine of development, the proximal processes. Beek [48] advocates a generative rather than confirmatory design of research and has some reservations claiming that insights and design implementation remains indefinite.

Most of the studies in the field of sport sciences that described athletes' personal characteristics have used analytical designs [49, 50]. These particular instruments devote more attention to the personal characteristics, mainly, resource characteristics) that individuals bring with them into any social situation [5, 7]. They are not immediately apparent, though sometimes they are induced, with differing degrees of accuracy, from the demand characteristics that are seen.

A critical appraisal of methodological quality showed that most studies need to address with more depth and with more accuracy their reflexivity and credibility boundaries, explicitly assessing the likely impact of their own personal characteristics (such as age, sex and professional status) and the methods used on the obtained data. Only two studies [24, 26] fully and successfully accomplished to meet theses methodological criteria.

Verification procedures used to help establish credibility/ trustworthiness of the study and reduce bias (e.g., prolonged engagement in the field, triangulation, peer review or debriefing, etc.) were best applied by Domingues and Gonçalves [24], La Voi and Dutove [26], Larsen, Alfermann and Christensen [51], Bengoechea and Strean [52] and Holt et al. [27]. Analyzing the quantitative studies, the study by Moore et al. [45] provided evidence that athletes and non-athletes are two distinct groups of students, highlighting the importance of overall healthy decision-making (i.e., avoiding substance use) and positive peer influence. This study had some report inaccuracies only in the intervention part; it revealed a well implemented and designed approach assessing healthy behaviors, and using sport practitioners as a specific population it is the only article to date which effectively used bioecological systems with quantitative measures.

The ecological approach has been lacking in research into talent development, and there have been calls for theoretically guided research [20, 21], prioritizing issues in youth sport such as proximal processes that unravel this development. Future research should also relate to determinants of social change and sport participation in youth deprived communities. Indeed, sport

commands a proven power to cross barriers, and create communities as this relates to public policy making and development through sports. Finally, future research should reveal the constraints and prospects of youth labor sport migration; they are precarious, unpredictable and often disappointing. The analysis should be focused on the particular dynamics that often expose young hopefuls to exploitation, for example in the form of human trafficking of various kinds.

Conclusion

Bronfenbrenner's bioecological model can be a starting point to comprehend the indirect influences that constrain sport and exercise behavior in various contexts, with multiple actors and different processes. With regard to what we need to know and potential future directions, some key themes become apparent: (1) most of the articles fail really extend Bronfenbrenner's work and accomplishments; (2) longitudinal studies are an avenue to pursue in the next years; (3) there is a strong need to elaborate upon quantifiable instruments to effectively measure proximal processes; (4) following this reasoning, it would be very profitable to conduct mixed method research to link the most effective way proximal processes to characteristics of the youth athletes under development; (5) there are some current trends that worry policy making, for example, labor migration and sport as a tool for social change; in which bioecological systems can constitute a powerful framework to address these issues. The interaction between characteristics of the person, process, context and time is the most efficient model to study the adolescent's disposition for sports and there remains a need to develop an ecological framework and a corresponding scientific method suitable for studying in an applied perspective. Regarding the applied practice, this could provide a more consistent and knowledgeable base from which one can intervene and implement interventions more effectively in the society as a whole.

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Annexes

Table 1. Quality Assessment on PPCT based articles. Checklist for assessing the quality of qualitative studies

Criteria	Studies																		
	1	2	4	6	8	23	30	32	38	61	62	63	64	65	80	81	82	83	
1 Question / objective sufficiently described?	2	2	2	2	2	2	2	1	2	2	2	2	2	2	2	2	2	2	
2 Study design evident and appropriate?	2	2	2	2	2	0	1	1	1	2	2	2	2	2	2	2	2	1	
3 Context for the study clear?	1	1	1	2	2	2	1	2	2	2	2	2	1	2	1	2	2	1	
4 Connection to a theoretical framework / wider body of knowledge?	2	2	2	1	1	2	2	1	2	1	1	2	2	1	1	2	2	2	
5 Sampling strategy described, relevant and justified?	1	1	1	2	2	1	1	1	1	1	1	2	1	1	1	2	2	1	
6 Data collection methods clearly described and systematic?	2	2	1	2	2	1	1	1	1	1	2	2	1	2	2	2	1	1	
7 Data analysis clearly described and systematic?	2	2	2	2	1	1	2	1	1	2	2	2	1	1	1	2	1	1	
8 Use of verification procedure(s) to establish credibility?	2	2	2	2	2	0	0	0	0	2	0	2	0	2	2	0	0	0	
9 Conclusions supported by the results?	1	2	2	2	1	2	2	1	2	2	1	2	2	2	1	2	2	2	
10 Reflexivity of the account?	0	2	0	2	1	0	0	0	1	1	0	1	0	1	0	1	1	0	
Total sum	15	18	15	19	16	11	12	9	13	16	13	19	12	16	13	17	15	11	

Note: Yes=2; Partial=1; No=0. Item 8 not attributable for Partial. A summary score was calculated for each paper by summing the total score obtained across relevant items and dividing by the total possible score (i.e.: $28 - (\text{number of "n/a"} \times 2)$, i.e. Total sum = (number of "yes" * 2) + (number of "partials" * 1). Total possible sum = 20. Summary score: total sum / total possible sum. BEF studies' reference numbers: 1= Domingues, & Gonçalves (2013a); 2= Domingues, & Gonçalves (2013b); 4= Domingues, & Gonçalves (2012); 6= La Voi, & Dutove (2012); 8= Larsen, Alfermann, & Christensen (2012); 23= La Voi (2011); 30= Botti, & Vieira do Nascimento (2011); 32= Carlson (2010); 38= Araujo, Fonseca, Davids, Garganta, Volossovitch, Brandão, & Krebs (2010); 61= Bengoechea, & Streat (2008); 62= Saraiva, & Barreiros (2008); 63= Holt, Tamminen, Black, Sehn, & Wall (2008); 64= Krebs, Copetti, Serpa, & Araújo (2008); 65= Holt, Tink, Mandigo, & Fox (2008); 80= Pope, & O'Sullivan (2003); 81= Bengoechea (2002); 82= Bengoechea, & Johnson (2001); 83= Vieira, & Vieira (2001)

Table 2. Quality Assessment on PPCT based articles. Checklist for assessing the quality of quantitative studies

Criteria	Studies	
	20	29
1 Question / objective sufficiently described?	1	2
2 Study design evident and appropriate?	1	2
3 Method of subject/comparison group selection or source of information/input variables described and appropriate?	2	2
4 Subject (and comparison group, if applicable) characteristics sufficiently described?	2	2
5 If interventional and random allocation was possible, was it described?	N/A	1
6 If interventional and blinding of investigators was possible, was it reported?	N/A	N/A
7 If interventional and blinding of subjects was possible, was it reported	0	1
8 Outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias? means of assessment reported?	1	2
9 Sample size appropriate?	1	2
10 Analytic methods described/justified and appropriate?	1	2
11 Some estimate of variance is reported for the main results?	1	2
12 Controlled for confounding?	1	2
13 Results reported in sufficient detail?	1	2
14 Conclusions supported by the results?	1	2
Total Sum	13	24

*Note: Yes=2; Partial=1; No=0; N/A. Items 1,2,4,13,14 not attributable to N/A A summary score was calculated for each paper by summing the total score obtained across relevant items and dividing by the total possible score (i.e.: $28 - (\text{number of "n/a"} \times 2)$ Total sum = (number of "yes" * 2) + (number of "partials" * 1). Total possible sum = 20. Summary score: total sum / total possible sum. BEF studies' reference numbers: 20= Krebs, Ramalho, Santos, Nazario, Nobre, & Almeida (2011); 29= Moore, Barnett, Brennan, & Gibson (2011)*