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Case Report

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# Dance screening practices in dance companies, dance schools and university dance programmes: An international survey of current practices

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## Abstract

**Background**: Dance performance requires the combination of both athletic and artistic demands. The health and well-being of dancers is of paramount importance, and one intervention that has been used to manage their health and performance is screening. There is a need to determine current screening practices to aid the management of dancers.

**Methods**: The Bristol online survey was used to determine screening practices in dance companies/schools and university dance programmes. The survey was available online between April 2018 and September 2018 and consisted of 39 questions which were divided into the following sections: (1) screening details, (2) physical fitness and joint screening, (3) injury screening, (4) dance specific movement screening, (5) health screening. Respondents included those individuals involved in dance screening.

**Results**: A total of 32 individuals participated in the study with physiotherapists and dance teachers most prevalent. Injury prevention (62.5%) and self-management (62.5%) were the most common aims of screening. Dancer screening occurred in a non-fatigued state in 90.63% of dancers. Flexibility (95.75%) was the most commonly assessed physical fitness component and the feet the most assessed joint (87.5%). Passive turnout (62.5%) and demi-plié (62.5%) were the most commonly assessed dance specific movements. Previous injury (87.5%) had the highest prevalence of general health questioning. Cardiovascular screening was performed by 21.88% of respondents and the Star Excursion Balance Test (34.38%) was the most commonly used movement screening tool. Hypermobility was screened by 75% of respondents and 28.13% of respondents used psychometric tests.

**Conclusion**: Physiotherapists and dance teachers were most frequently involved in screening, and the main aims were to improve the dancers health and well-being. There may be a need to consider the potential influence of acute fatigue on screening and a greater assessment of the strength, aerobic fitness and speed is required. Passive and active turnout were frequently screened and may be important in identifying potential injury risk. Cardiac and psychometric screening was limited and may require greater consideration.

**Keywords**: Dance screening, Injury prevention, Career longevity, Flexibility, Passive turnout, Cardiovascular screening, Star Excursion Balance Test, Hypermobility

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## Introduction

Dance requires short sets of explosive movements requiring balance, athleticism and artistry [1], indicative of movement complexity and intensity. Due to these demands, physical attributes including strength, speed, power, agility, cardiovascular endurance, flexibility, coordination and balance contribute to effective performance. Vertical ground reaction forces increase with the intensity of the dance routine [2,3] and mechanical loading increases with movement difficulty [4] and dancers are required to exceed normal anatomical range [5]. One potential consequence of these demands is injury which is a challenge for Sports Medicine professionals due to its significant physical, psychological and financial impact and multifactorial nature [6]. Injuries in dance result from a complex interaction between intrinsic, extrinsic and situational variables [7]. Dance screening practices are a vital component of injury prevention with a recent systematic review and meta-analysis identifying range of motion (ROM), anthropometric data and posture, dance specific positions, hypermobility, clinical diagnostic tests, and musculoskeletal screening tools as current measurements that have been investigated as predictors of injury [7]. Injury rates range from 0.62 to 5.60 injuries/1000 hours with most injuries occurring in the lower limb [5, 8-10].

A general movement screen may lack specificity and value exists in developing screening practices that can predict the likelihood of injury to maximise the specificity and therefore ability of the test to determine injury [11]. Recent research has focussed on the potential effects of fatigue on screening performance and potential implications for injury [12,13] and the influence of fatigue may require greater consideration in screening practices. In addition to injury prevention, screening has previously been used to monitor performance deficits with the Star Excursion Balance Test reported to be a predictor of functional turnout angle [14] and used to assess proprioceptive training [15]. The implementation of effective injury screening tools could have positive physical and psychological impact for dancers by allowing participation with reduced injury risk. Traditionally within dance "*screening*" has sometimes been used as a term to describe the selection of dancers following an assessment of their performance at an audition. This study prefers to consider the term "*screening*" in a musculoskeletal and physical health domain. Currently it is unclear the extent to which dance companies and university dance programmes are performing screening of dancers prior to participation. Furthermore the demands of dance are varied e.g. ballet requires partner lifting and tap dancing utilises the lower extremity as a percussion instrument and such variations combined with the different levels of dance have implications for injury and performance.

The primary aim of this study was to determine current screening practices in dance companies/ schools and university dance programmes including what tests are been performed, by whom and how the information is been utilised with the aim of providing information that can potentially be used to improve dancer's health and performance. The study utilised a broad genre and level of dance and an online platform with the aim of developing an international perspective on current practices.

## Method

### Design

The study involved the use of an online survey utilising the Bristol on-line survey platform (www.onlinesurveys.ac.uk) which was distributed online between April 2018 and September 2018.

### Survey development

The survey questions were developed by the researcher, a musculoskeletal physiotherapist with 18 years' experience of utilising screening practices in sport and dance. The researcher had received training with the Bristol online survey at their university. The questions were reviewed in a pilot study survey by five individuals involved in dance screening (physiotherapist, sports scientist, physician, biomechanist and university dance teacher) to ensure face validity and that the questions were of an appropriate level to identify any potential ambiguous questions. These five individuals agreed upon the importance of the questions subsections and that they were of interest to practitioners working with dancers. The survey was published in English and Portuguese with translation verified by a Portuguese speaking language teacher,

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physician and physiotherapist who worked in the domain of dance medicine. This translation was performed to increase international access to the survey and due to development of a Brazil-UK dance network which was able to assist with translation and the dissemination of the survey.

### Participants

All participants were aged over 18 and volunteered to participate in the study. The term "*respondents*" will be used to identify those who completed the survey and "responses" was used to define the number of answers to a particular question. The demographics of the respondents is reported in table 1. The survey aimed to recruit individuals who potentially might be involved in dance screening namely university dance lecturers, dance teachers, physiotherapists, sports scientists, strength and conditioning coaches and any other appropriate individual. Respondents were identified using the following methods: (1) via internet searches of university dance programmes to identify individuals teaching dance programmes in the UK (63 individuals contacted via email), (2) advertisements posted via One Dance UK website, (3) Dance Science UK Facebook webpage (1,838 members), and (4) Internet search of dance companies in Europe/USA/Canada (88 companies contacted). Potential contacts were also provided via dance networks such as the Brazil-UK dance network and university dance teachers and academics (12 contacts).

### Survey

The survey consisted of 39 questions which were divided into the following sections: (1) screening details, (2) physical fitness and joint screening, (3) injury screening, (4) dance specific movement screening, (5) health screening. All questions allowed respondents to select an appropriate response or select the "*other*" option if the appropriate response was not available and provide an answer by free text. There was no time constraint on respondents to complete the survey.

### Ethical considerations

All respondents completed informed consent forms and were provided with an information sheet before commencing the study. Ethical approval was granted by the University Research Ethics Committee in accord with the Helsinki Declaration of 1975.

### Data analysis

Survey responses were reported as descriptive statistics (actual score and percentage) to allow an overview of current screening practices.

## Results

The total survey response rate was calculated for university dance programmes for which 3/63 (4.76%) respondents indicated they were involved in screening and would complete the survey. The aim of the survey was not to report how many dance companies/schools and university were not screening but what was been performed. Therefore from these non-responders it cannot be presumed that they do not perform screening. For the dance companies contacted via email, 2/88 (2.27%) indicated they would complete the survey. From the other methods of recruitment, it was not possible to calculate response rate due to anonymity. A total of 32 respondents completed the study with physiotherapists, 14 (43.75%) the most prominent profession. Respondents were from the UK, Brazil, Canada, USA, Slovenia, Australia, New Zealand and Ireland.

Table 1: Demographics of survey respondents and those involved in the screening process

| Profession | Involved in the screening process |
|---|---|
| Physiotherapist 14 (43.75%) | Physiotherapist 19 (38%) |
| Academic researcher 2 (6.25%) | Sports Scientist 9 (18%) |
| Sports Therapist 1 (3.13%) | Dance teacher 11 (22%) |
| Strength and conditioning coach 2 (6.25%) | Physician 5 (10%) |
| Dance teacher 7 (21.88%) | Sports Therapist 1 (2%) |
| Physician 2 (6.25%) | Dance scientist 1 (2%) |
| Ballet school director 1 (3.13%) | Nurse 1 (2%) |
| Podiatrist 1 (3.13%) | Dance science researcher 1 (2%) |
| Scientist 1 (3.13%) | Pilates teacher 1 (2%) |
| Pilates teacher 1 (3.13%) | Podiatrist 1 (2%) |

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## Screening details

General aims of screening

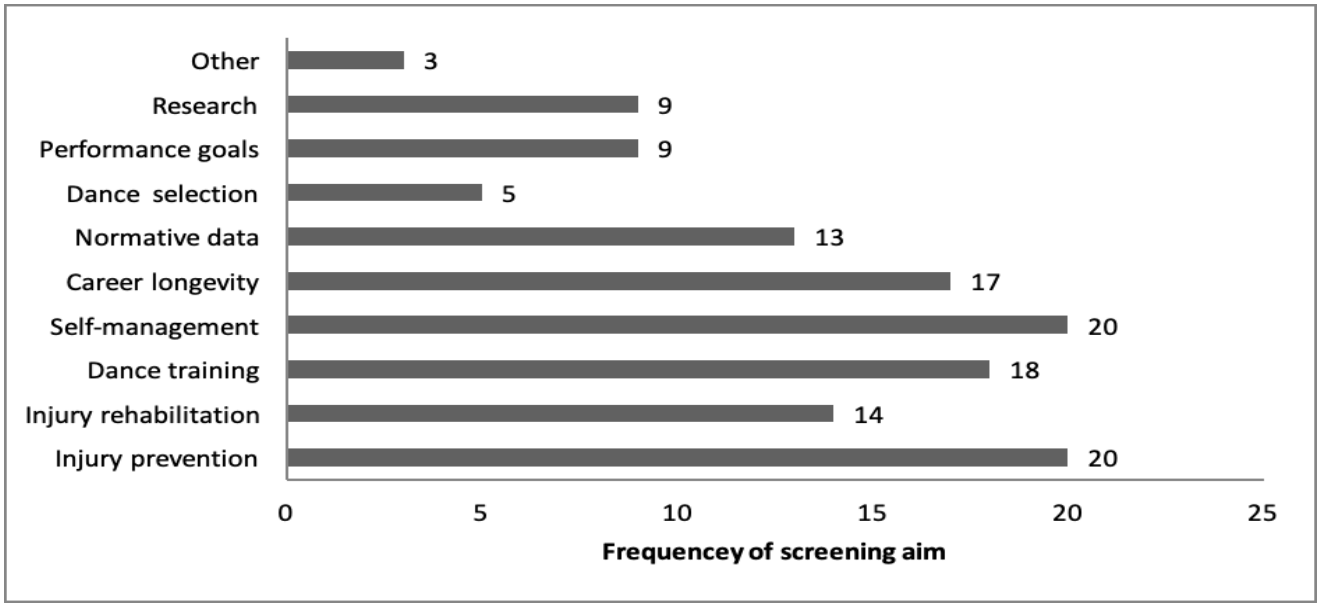


Figure 1. Reports the general aims of screening identified by respondents.

### Figure 1 Screening aims

The most prominent aims of screening was injury prevention (20/128 responses, 15.6%), self-management of fitness and injury among the dancers (20/128 responses, 15.6%), effective dance training (18/128 responses, 14.1%), increase career longevity (17/128 responses, 13.3%), injury rehabilitation (14/128 responses, 10.9%) and to provide normative data for performance monitoring (13/128 responses, 10.2%). Other aims that were given were to "*remove the stigma of seeking healthcare*", "*to connect with clients*" and to get clients "*onside*" with screening.

### Frequency of screening

Respondents reported that the screening process occurred monthly, 5 respondents (15.63%), 1-3 months, 6 respondents (18.75%), 4-6 months, 2 respondents (6.25%), 7-12 months, 11 respondents (34.38%), more than 12 months, 3 respondents (9.38%) and other, 5 respondents (15.63%) which included weekly, 1 respondent (3.13%) and responses of "*depends on the clinical situation*", "*when the students have an injury*", "*during auditions*", "*dancers self-select*", "following injury every 4 to 6 weeks" were also recorded.

### Involvement in the screening process

Table 1 contains information regarding who is involved in the screening process.

### Fatigue status

Twenty-nine respondents (90.63%) performed screening in a non-fatigued state and 3 respondents (9.38%) performed screening in a fatigued state.

### Feedback and intervention

Twenty-nine respondents (90.63%) provided dancers with feedback and three respondents (9.38%) did not provide dancers with feedback on their results. Twenty respondents (62.5%) provided an intervention programme and 12 respondents (37.5%) did not based upon the screening results.

## Physical fitness and joint screening

Table 2 and table 3 report physical fitness components that respondents identified as part of the screening process. Flexibility, 30 respondents (95.75%) was the most commonly assessed component and speed, 8 respondents (25%) the least considered physical fitness component. The one leg stand, 23 respondents (71.88%) and straight leg raise, 22 respondents (68.75%) were the individual components that were most prevalent in physical fitness screening.

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Table 2: Strength, flexibility and balance components of the screening process

| Strength | Flexibility | Balance |
|---|---|---|
| Calf raises 19 (59.38%) | Straight leg raise 22 (68.75%) | One leg stand 23 (71.88%) |
| Isokinetic dynamometer 5 (15.63%) | Thomas Test 11 (34.38%) | Tekscan 1 (3.13%) |
| Adductor squeeze 2 (6.25%) | Toe touch 12 (37.50%) | One leg stand eyes closed 1 (3.13%) |
| Grip strength (hand held dynamometer) 3 (9.38%) | Obers test 6 (18.75%) | Star Excursion Balance Test 1 (3.13%) |
| Manual muscle testing 1 (3.13%) | Knee to wall test 3 (9.38%) | Single leg squat 1 (3.13%) |
| Observing functional movement patterns 1 (3.13%) | Internal/external hip rotation 1 (3.13%) | Single leg rise 1 (3.13%) |
| 10 RPM leg press 1 (3.13%) | Ballet moves (e.g. abraseque) 1 (3.13%) | One leg knee bend in parallel and turnout 1 (3.13%) |
| Hamstring curls/quadriceps extensions 1 (3.13%) | Beighton score 1 (3.13%) | Modified Rhomberg, one leg closed 1 (3.13%) |
| McGill's Strength test (trunk) 1 (3.13%) | Splits 1 (3.13%) | Aeroplane sequence 1 (3.13%) |
| Countermovement jump on bilateral force plate 1 (3.13%) | Goniometer measurement with the hip in flexion and external rotation 1 (3.13%) | Balance time in passé or arabesque 1 (3.13%) |
| Countermovement jump 1 (3.13%) | Shoulder flexibility (circumduction) 1 (3.13%) | Ballet specific tendu en croix in centre 1 (3.13%) |
| Push up test 1 (3.13%) | Forward bend sitting 1 (3.13%) | - |
| Seated shoulder press 1 (3.13%) | - | - |
| Side plank to failure 1 (3.13%) | - | - |
| Repeated single leg squat 1 (3.13%) | - | - |
| Ballet specific movements 1 (3.13%) | - | - |
| Not tested 10 (31.25%) | Not tested 2 (6.25%) | Not tested 6 (18.75%) |

Abbreviations: RPM: Rep max

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Table 3: Aerobic fitness, speed and power components of the screening process

| Aerobic fitness | Speed | Power |
|---|---|---|
| Multistage fitness test 3 (9.38%) | 10 metre sprint test 2 (6.25%) | Counter movement jump 8 (25%) |
| Dance Aerobic Fitness Test (Ballet) 5 (15.63%) | 30 metre sprint test 4 (12.50%) | Vertical jump 15 (46.87%) |
| Dance Aerobic Fitness Test (Contemporary) 8 (25%) | T-test 3 (9.38%) | Drop test 1 (3.13%) |
| 3 minute Harvard Step test 2 (6.25%) | 60m sprint 1 (3.13%) | Repetitive jump test 1 (3.13%) |
| VO2 max treadmill test 1 (3.13%) | 600m sprint 1 (3.13%) | Observation of eccentric control with sauté/ single leg hop 1 (3.13%) |
| 3 minute step test with accelerated bpm to 112 1 (3.13%) | - | 1 RPM 1 (3.13%) |
| Class situation 1 (3.13%) | - | 3 RPM hop (3.13%) |
| - | - | Repeated hop test (5 single leg max repeatedly) 1 (3.13%) |
| - | - | Movement Competency Screening Tool 1 (3.13%) |
| - | - | Video assessment of jump land control 1 (3.13 %) |
| - | - | Dance specific jumps 1 (3.13%) |
| Not tested 15 (46.88%) | Not tested 24 (75%) | Not tested 7 (21.88%) |

Abbreviations: VO2 max: Maximum aerobic capacity, BPM: Beats per minute, RPM: Rep max

## Orthopaedic assessment

### Anthropometric measurements

Twenty-three respondents (71.88%) performed measurement of the following anthropometric measures: height, 22 respondents (68.75%), body mass, 15 respondents (46.88%), body mass index, 16 respondents (50%), body composition, 11 respondents (34.38%), 3D scan, 1 respondent (3.13%). Nine respondents (28.13%) did not perform anthropometric measurements.

Table 4 reports the joint measurements performed at the feet, knee, hip and spine and symmetry considerations. The feet, 28 respondents (87.5%), hip, 26 respondents (81.25%) and spine, 26 respondents (81.25%) were the joints that were most prevalent during screening. Hip ROM, 22 respondents (68.75%) and ankle ROM, 19 respondents (59.38%) were the individual components that were most prevalent.

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Table 4: Joint and symmetry screening

| Feet | Knee | Hip | Spine | Symmetry |
|---|---|---|---|---|
| Hallux valgus 11 (34.38%) | Knee ROM 12 (37.5%) | Hip strength 14 (43.75%) | Lumbar ROM 13 (40.63%) | Leg length 18 (56.25%) |
| Ankle ROM 19 (59.38%) | Muscle strength 13 (40.63%) | Hip ROM 22 (68.75%) | Lumbar strength 3 (9.38%) | Upper limb symmetry 9 (28.13%) |
| Ankle muscle strength 12 (37.5%) | Genu valgum 14 (43.75%) | Quadrants 1 (3.13%) | Thoracic ROM 11 (34.38%) | Lower limb symmetry 8 (25%) |
| Foot type 14 (43.75%) | Genu varum 11 (34.38%) | Adductor squeeze at 0° and 45° 1 (3.13%) | Thoracic strength 6 (18.75%) | Femoral ant/retroversion 1 (3.13%) |
| Big toe ROM 17 (53.13%) | Alignment via squat assessment 1 (3.13%) | In ballet, external rotation in retiré 1 (3.13%) | Cervical ROM 9 (28.13%) | - |
| Alignment and stability via double and single leg rises 1 (3.13%) | Static lower limb control with squat 1 (3.13%) | - | Cervical strength 2 (6.25%) | - |
| Flexor Hallucis Longus length 1 (3.13%) | Orthopaedic tests: Ant/post draw, duck walk, MCL/PCL, Thessaly 1 (3.13%) | - | Scoliosis 18 (56.25%) | - |
| Proprioception 1 (3.13%) | Knee alignment in parallel single leg bend and demi plie on one leg 2 (6.25%) | - | Hyperlordosis 9 (28.13%) | - |
| Force plantar flexion 1 (3.13%) | Patella mobility 2 (6.25%) | - | Kyphosis 11 (34.38%) | - |
| Observe rise to demi pointe 1 (3.13%) | - | - | Spondylolisthesis 3 (9.38%) | - |
| 3d scan longitudinal measurement of the foot 1 (3.13%) | - | - | Core capacity and control assessments 1 (3.13%) | - |
| Mid tarsal joint ROM 1 (3.13%) | - | - | Slump test 1 (3.13%) | - |
| Not tested 4 (12.5%) | Not tested 7 (21.86%) | Not tested 6 (18.75%) | Not tested 6 (18.75%) | Not tested 10 (31.25%) |

Abbreviations: ROM: Range of motion, MCL: Medial collateral ligament, PCL: Posterior collateral ligament

## Injury screening

### Injury audit, injury severity and mechanism of injury

Nineteen respondents (59.38%) collected injury audit data and 13 respondents (40.63%) did not. Twenty-five respondents (78.13%) asked questions regarding injury severity and mechanism of injury and 7 respondents (21.88%) did not.

### Fatigue, warm up and sporting activity

Twenty-two respondents (68.75%) asked questions regarding overtraining and fatigue during screening and 10 respondents (31.25%) did not. Twenty-four respondents (75%) asked whether dancers warmed up during screening and 8 respondents (25%) did not. Twenty-one respondents (65.62%) recorded activity in other sporting activities during screening and 11 respondents (34.38%) did not.

## Dance specific screening

### Dance genre and dance specific movements

Twenty-six respondents (81.25%) asked questions regarding dance genre during screening and 6 respondents (18.75%) did not. Figure 2 reports the dance specific movements that were observed with passive turnout 20 (62.5%) and demi-plié 20 (62.5%) most commonly assessed.

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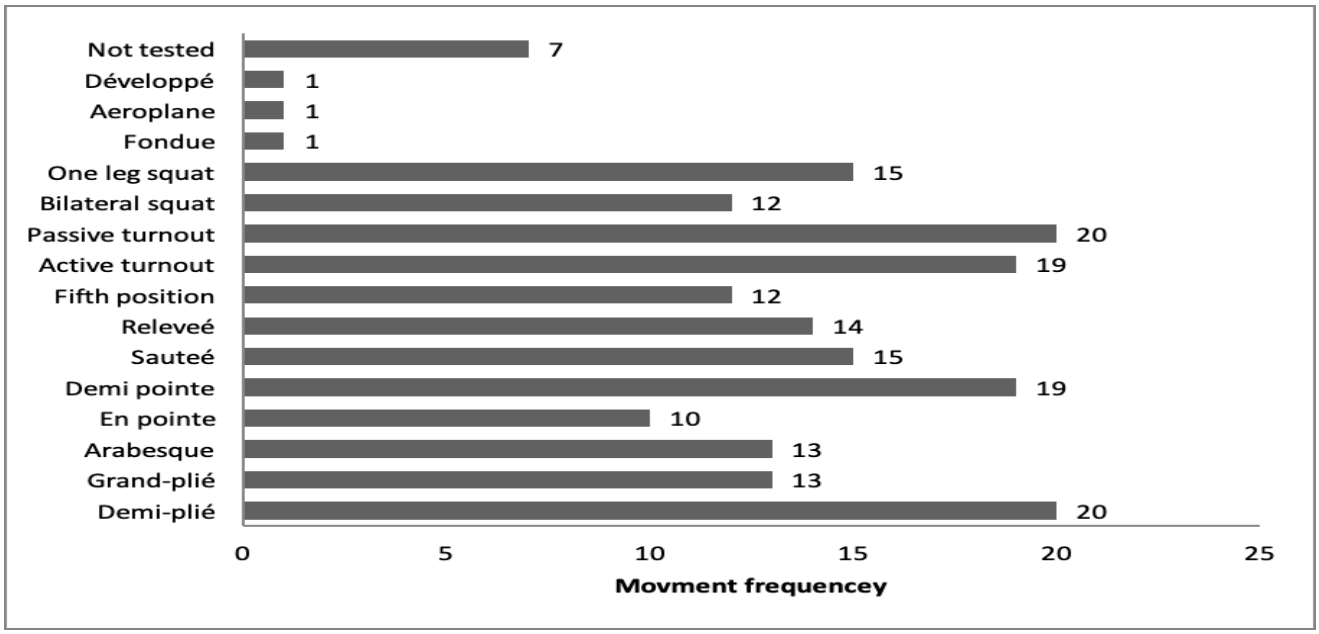


Figure 2. Dance specific movement screening

### En pointe

Nineteen respondents (59.40%) asked questions regarding what age dancers commence en pointe while 13 respondents (40.60%) did not.

## Health Screening

### General health

Figure 3 reports the subject areas asked regarding general health. The most commonly assessed component was previous injury, 28 respondents (87.5%).

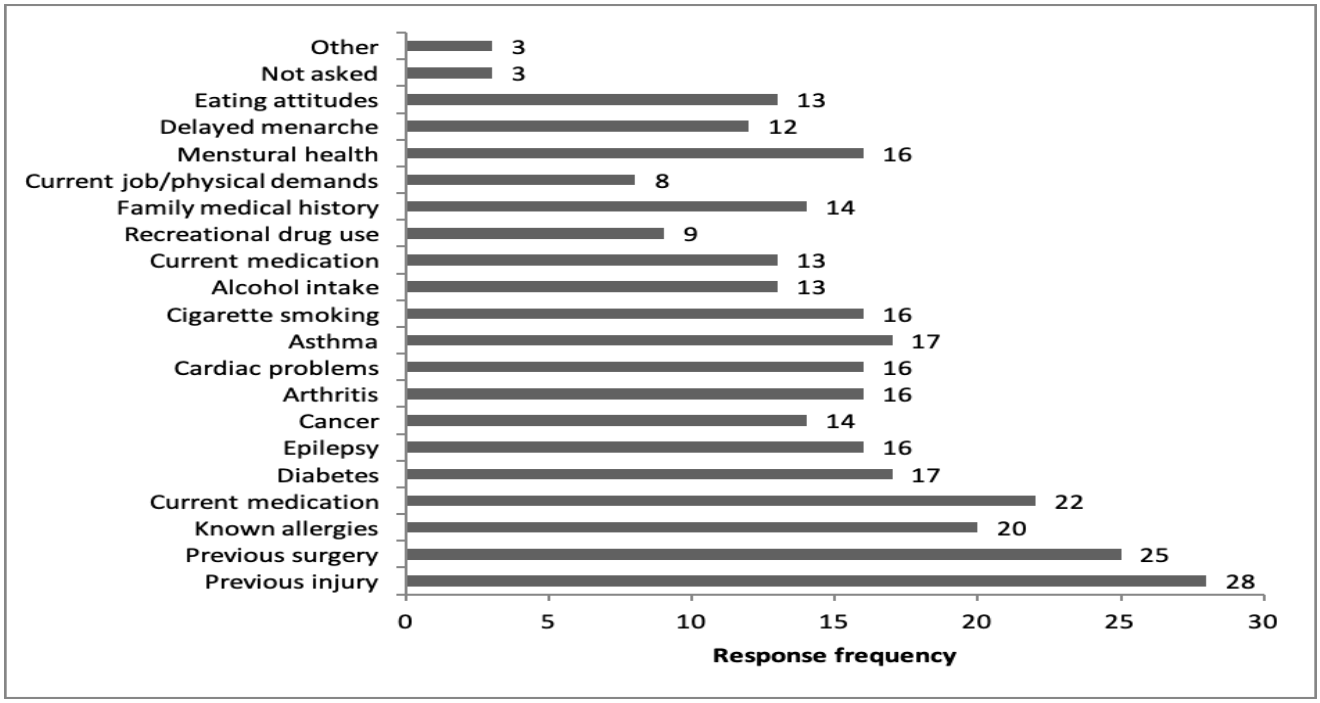


Figure 3. Dance specific movement screening

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### Cardiovascular screening

Seven respondents (21.88%) performed cardiovascular screening and 25 respondents (78.13%) did not. When performed it was undertaken with the following frequency: 1-3 months, 1 respondent (3.13%), 4 to 6 months, 1 respondent (3.13%), 7 to 12 months, 2 respondents (6.25%), more than 12 months, 3 respondents (9.38%). Cardiac screening commences at 14 years, 2 respondents (6.25%), at 15 years, 3 respondents (9.38%), at the first screening (9.38%), 2 respondents (6.25%) and one respondent (1.12%) had an arrangement with a hospital for screening via "*cardiac risk for the young*".

### Movement screening

The movement screening tests used by respondents is reported in figure 4. The most prevalent measurement was the Star Excursion Balance Test, 11 respondents (34.38%).

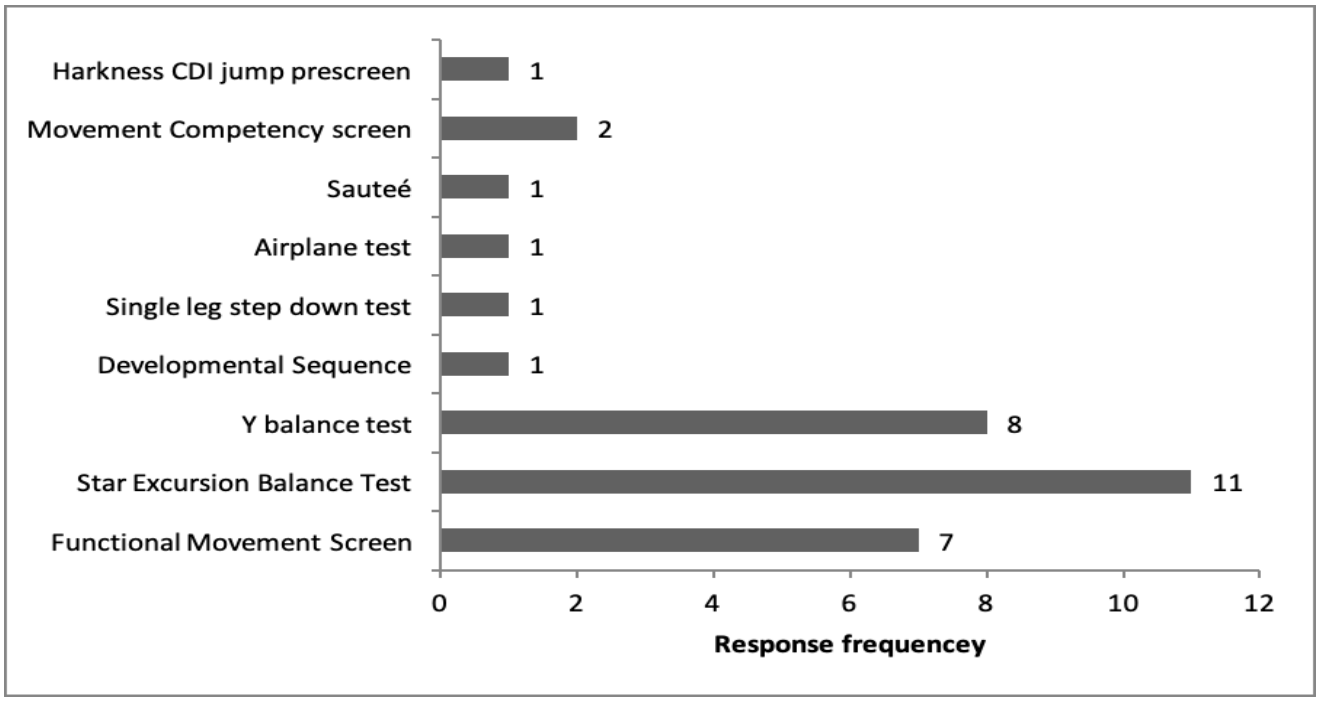


Figure 4. Movement screening tools

Abbreviations: CDI: CUNY Dance Initiative

### Hypermobility

Twenty-four respondents (75%) screened for hypermobility and 8 respondents (25%) did not. Of those that screen for hypermobility, 20 respondents (83.33%) used the Beighton score and 4 respondents (16.66%) did not. Seventeen respondents used the following Beighton score cut off points: Beighton score of 2, 1 respondent (5%), Beighton score of 4, 5 respondents (25%), Beighton score of 5, 9 respondents (45%), Beighton score of 6, 1 respondent (5%), Beighton score of 7, 1 respondent (5%). 3 respondents (15%) did not state a Beighton score cut-off.

Seventeen respondents (53.13%) used the Brighton criteria to screen for hypermobility and fifteen respondents (46.88%) did not.

### Psychology assessment

Nine respondents (28.13%) used psychometric tests to measure anxiety, depression and general mood state and 23 respondents (71.88%) did not. The psychometric tests were: Dimensions of Anger Reactions (DAR) [16], 1 respondent (3.13%), Profile of Mood States (POMS) [17], 1 respondent (3.13%), State and Trait anxiety [18], motivation, 1 respondent (3.13%), self-image, 1 respondent (3.13%), personality, 1 respondent (3.13%), values, 1 respondent (3.13%), 6 depression screen questionnaires, 1 respondent (3.13%) and unknown, 1 respondent (3.13%).

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## Discussion

The primary aim of this study was to determine current screening practices in dance. The study utilised a broad genre and level of dance and an online platform with the aim of developing an international perspective on current practices.

### Screening details

The survey was completed by 10 different professions of which physiotherapist and dance teacher was the most prevalent. Injury prevention, self-management, dance training and career longevity were identified as the main aims of screening. These all highlight that the management of the health and well-being of the dancer is of paramount importance. Injury has considerable physical and psychological impact and its prevention follows the Van Mechelen model of injury prevention [19] which requires identification of potential risk factors before the implementation of preventative measures. This approach would increase self-management of health and dance training and hopefully impact positively on career longevity.

Screening frequency varied from weekly to more than 12 months with 7 to 12 months the most common interval (34.38%). However, for injury prevention is it possible that screening might be advised on a more frequent basis with 37.51% of screening occurred from weekly to 3 months. Future studies may consider investigating screening frequency in relation to injury rates and performance changes. Some respondents only use screening following injury. However, this does not allow for potential injury prevention strategies to be implemented. Fatigue is the decline in force or power produced by a muscle [20] resulting in a transient decrease in muscular performance [21] and may lead to disrupted movement patterns resulting in injury [22, 23]. Only 9.38% of respondents screened in a fatigue state. The effects of fatigue on screening has been found to be task specific with the movements of the Star Excursion Balance test (composite score, anterior, posterolateral, and posteromedial directions) demonstrating non-significant findings for both dominant and non-dominant legs pre and post-performance of the Dance Aerobic Fitness Test [12]. In contrast, fatigue effects were observed in elements of the Functional Movement Screen (deep squat, hurdle step non-dominant and in-line lunge non-dominant and dominant legs) pre and post-performance of the Dance Aerobic Fitness Test [13]. Therefore, there may be a need to consider potential fatigue effects during screening and the investigation of dance specific movements under the influence of fatigue may be beneficial. The majority of respondents provided dancers with feedback which could be considered best practice in allowing the dancer to take greater responsibility and formulate their own goals.

### Physical fitness and joint screening

Flexibility was deemed the most important component to measure with 93.77% of respondents testing this component with the straight leg raise the most prevalent component. Strength was measured by 68.75% of respondents with calf raises the most prominent accounting for 46.34% of strength tests, while flexibility tests of the calf as assessed by the knee to wall test accounted for only 4.92% which may suggest that practitioners are not always considering the action of specific muscle groups and testing all their aspects. The relatively low value of strength testing may represent that flexibility remains the primary focus in the development of physical fitness components. Within the measurement of flexibility, a number of dance specific movements were measured by respondents including movements in parallel, turnout and arabesque which may highlight the need for dance specific movements.

Only 25% of respondents measured speed which may reflect the possibility that it is not deemed essential for performance or a lack of tests with relevance to dance performance with the 30 metre speed test and T-test [24] which also measures agility most prominent. With regard to aerobic fitness, 53.12% of respondents measured this component the reasons for this relatively low number could relate to how long the tests can potentially take and that they may impact on the performance of other tests if done on the same day or a consensus that power, balance and flexibility are more important. The Dance Aerobic Fitness Test [25] was the most prevalent aerobic test. Power was measured by 78.12% of respondents with a large variety of different tests used with the vertical jump most prominent (46.87%). Potentially some respondents may feel that jump performance provides a measure of speed performance more

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appropriate to dance performance than the measurement of linear speed.

### Anthropometric measurements

Height (68.75%) was the most commonly measured anthropometric variable and may reflect the importance of monitoring growth and along with body mass is required for body mass index calculation. Body composition was measured by 34.38% of respondents and future research may wish to clarify the methods utilised e.g. skinfold measurements, bodpod.

### Orthopaedic measurements

The feet (87.5%), hip (81.25%), spine (81.25%), and knee (78.14%) were all included in screening to a similar degree which is in contrast to the findings with physical fitness. Despite the aesthetic demands of dance only 68.75% of respondents screened for symmetry. The screening of the lower limb might highlight the high prevalence of lower limb injuries associated with dance. At the ankle, the most commonly assessed were ankle ROM, big toe ROM and foot type while at the knee it was genu valgum, muscle strength and genu varum. Knee ROM was not considered as important as Ankle ROM which may reflect the importance of the ankle to dance performance. At the hip, ROM and strength were the most common measurement. This focus on ROM is supported by the findings of a systematic review [7] which identified hip ROM as a predictor of injury and this measurement was the most prevalent across the orthopaedic measurements. At the spine, scoliosis was measured with the greatest frequency and a higher prevalence of back injuries has been reported in scoliotic dancers [26]. ROM measurements at the lumbar, thoracic and cervical spine were more prevalent that strength assessment in these regions and there may be a need to consider both aspects when performing spinal assessment. All regions of the spine should be assessed due the kinetic chain and loading mechanics. The author acknowledges that in the future the shoulder, elbow and wrist should be included in questioning regarding orthopaedic measurement.

## Injury screening

### Injury audit, injury severity and mechanism of injury

The finding that 59.38% of respondents collected injury data and that 78.13% of respondents asked questions regarding injury severity and mechanism of injury highlights the importance of injury prevention. The majority of those who collected injury data (85%) were physiotherapists, physicians and strength and conditioning coaches which may highlight their professional training in injury surveillance.

### Fatigue, warm up and sporting activity

The finding that 68.75% of respondents asked questions regarding overtraining and fatigue during screening demonstrates an awareness that fatigue and overtraining are injury risk factors. This is in contrast, however, to the number of respondents who actually screened in a fatigued state. Currently, some respondents are not considering the acute fatigue response when screening but are aware of the influence of chronic fatigue, and the potential overuse injury risk due to cumulative fatigue stressors.

## Dance specific screening

### Dance genre and dance specific movements

Questions regarding dance genre during screening were prominent and may reflect an understanding of the different demands of dance genres. Dance specific movements are a prominent part (78.12%) of the screening process and may highlight that respondents are considering the movement patterns of specific movements with the vast majority of movements from ballet. Monitoring of passive and active turnout is encouraging as these movements have been identified as a predictor of injury [7]. The measurement of one leg squat and bilateral squat is in agreement with previous research that has identified that low performers in the deep squat make gross movement errors [27] and asymmetry may result in inappropriate muscle recruitment or weight transference. Successful deep squat performance requires the coordination of stability and mobility throughout the kinetic chain [28] and weakness and/or limited mobility in the lower extremities reduce deep squat performance [29]. Furthermore deep squat performance has been identified as the primary predictor of mechanical joint loading in dancers during the Dance Aerobic Fitness Test [30].

The age of going en pointe may have importance with regard to growth plate development and

determine when a dancer is ready with regard to having appropriate pelvic alignment control and appropriate flexibility and strength in the ankle. Dancers most commonly start pointe work around the age of 12 years and a force 12 times body weight can be experienced through the ankle and foot [31].

## Health screening

A variety of themes very investigated via general health questioning and 90.62% of respondents asked questions regarding general health which highlights awareness of the need to assess general health. Unfortunately the survey did not investigate what the respondents do when they identify a potential problem (e.g. onward referral if appropriate) and this could be considered in future research. The most commonly asked questions were previous injury and surgery which relates to the main aims of screening identified. Key medical areas such diabetes epilepsy, cancer, arthritis, cardiac problems, asthma and family medical history were not as prevalent as might be expected and the reasons for this require further investigation. It may relate to some respondents who undertake screening not feeling qualified to ask these questions however it would be hoped that these questions would be asked by an appropriate individual prior to dancing commences. Eating attitudes (40.63%), menstrual health (50%) and delayed menarche (37.5%) may relate to the Female athlete triad [32] and aspects of the Relative Energy Deficiency in Sports (RED-S) [33] and should be considered in screening. Menstural dysfunction and low bone mineral density can be related to dietary restrictions and low body mass associated with dancers [34, 35].

### Cardiovascular screening

A total of 21.88% of respondents performed cardiovascular screening. One respondent identified that their dancers had access to cardiac screening via "Cardiac risk in the young" (www.c-r-y.org.uk) based in the UK. Screening was identified as commencing at the ages of 14 and 15 years and the majority of respondents who performed cardiac screening in this survey were professional dance companies. An analysis of sudden cardiac deaths in the USA in young athletes identified an incidence of sudden cardiac death of 0.61/100,000 [36] and it might be worthwhile for dance companies/schools and university programmes currently screening to consider developing links to commence a cardiac screening programme. Future research could aim to determine what specific cardiac screening tests are been performed.

### Movement screening

The most commonly performed movement screening test was the Star Excursion Balance Test (33.33%) [37] followed by its related test the Y-balance test [38] (24.24%). The Star Excursion Balance Test challenges dynamic postural control and requires strength, proprioception and flexibility [39] and limb gesturing movements similar to dancers pointing the targeting toe in space while maintaining balance on the stance leg [40]. However there is a possibility that the Y balance test is not challenging enough for dancers due to the limited changes observed in its performance in a fatigued state [12] and dancers have enhanced balance in comparison to other groups and may demonstrate more distinct and variable kinematic strategies which facilitate performance of the SEBT [41]. The Functional Movement Screen (21.21%) featured highly and future research may wish to ask respondents which components are most important. Other screening tests related to dance specific movements such as the sauté [42, 43].

### Hypermobility

Hypermobility was screened by 75% of respondents and 83.33% used the Beighton score with cut off points of 4, 5 and 6 most prevalent in agreement with previous findings [44] however there may be a need to consider the use of lumbar flexion in scoring due to its previously highly reported prevalence in dancers [45]. The finding that 53.13% of respondents used the Brighton criteria demonstrates that respondents investigate a number of aspects of hypermobility however future research may wish to enquire whether the recently developed hypermobility spectrum [46] is been utilised. The Beighton score has previously been identified as a predictor of arthralgia and dislocation/subluxation [47] which form part of the Brighton Criteria [48] and therefore the recording of Beighton score may have value for injury prevention during screening.

### Psychology assessment

Psychometric tests were used to measure anxiety, depression and general mood state and a variety of

psychometric tests were used with not one test been used by more than one participant. The psychometric tests that were used included: DAR [16], POMS [17] and State and Trait anxiety [18]. This lack of use and consistency of psychometric tests applied may represent the fact that no psychologists were identified as been involved in screening process.

## Limitations

The findings of this survey are limited to the respondents and by the level of detail provided in answers. Future research could consider a great level of free text for respondents to provide further information. When contacting potential respondents via email there is no way of knowing how many of the respondents are either not involved in screening or merely chose not to participate in the survey. A larger sample size would have been beneficial as this would potentially have allowed a comparison of screening procedures between different countries and between different dance levels.

## Conclusion

The survey provided an overview of current screening practices and identified that physiotherapists and dance teachers were most frequently involved, and the main aims were to improve the dancer's health and well-being. There may be a need to consider the potential influence of acute fatigue on screening and a greater assessment of the strength, aerobic fitness and speed is required and there should be greater consideration of all aspects at a joint (e.g. strength and ROM). Passive and active turnout were frequently screened, and this may be important in identifying potential injury risk. There may be a need for certain areas of the general health section to be considered in greater depth with regard to medical conditions and those aspects related to RED-S. Cardiac and psychometric screening was limited and this might need to be considered to provide a more holistic approach to future dance screening.

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