Preferences for exercise and physical activity support in adolescent and young adult cancer survivors: a cross-sectional survey

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Abstract

Purpose Exercise and physical activity (hereafter, collectively referred to as PA) preferences and benefits are becoming increasingly well characterised in cancer survivors, yet evidence from adolescent and young adult cancer survivors (AYAs) is scant. We describe the overall PA behaviour and support preferences of AYAs and explore subgroup differences to inform AYA-specific research and support.

Methods AYAs diagnosed with cancer between the ages of 18–39 years, irrespective of current age, were approached in clinic at a large cancer centre for this cross-sectional survey that assessed self-reported demographics, medical history, PA behaviour and PA support preferences.

Results A total of 318 AYAs completed the survey. Approximately 40% of AYAs were not meeting PA guidelines, and only 5% reported engagement with cancer PA support services. Most AYAs wanted PA support (78%), to increase PA levels (70%), and were interested in engaging in PA interventions that were individually supervised (82%), home-based (79%), performed ≥3 days/week (75%) and for ≥30 minutes/session (78%), offered following treatment (63%), restricted by age (63%), and involved strength (83%), walking (78%), and flexibility (75%) exercise. PA preferences most often differed according to sex, treatment status, current PA behaviour and PA support setting.

Conclusion AYAs have a great capacity and interest in specific types of PA support. Poor engagement with existing PA support services highlights the need for further AYA-specific research. Better understanding of AYAs’ unique PA behaviour and support preferences can inform the development of urgently needed research and support services for this understudied and rapidly growing population.

Keywords Needs assessment · Survivorship · Health behaviour · Behavioural medicine · Patient preference

Introduction

Almost 80,000 adolescents and young adults (i.e. aged 15–39 years) are diagnosed with cancer in North America each year [1–3]. Improved cancer screening and treatment strategies have resulted in an overall five-year relative survival rate of 83% for adolescent and young adult cancer survivors (AYAs), with many expected to live 50–60 years beyond diagnosis [1].

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However, exposure to anti-cancer therapies and concomitant changes in protective health behaviours during these formative years increases the risks of numerous physiological (e.g. cardiovascular disease) and biopsychosocial (e.g. fatigue) sequelae in AYAs [4]. The complex mechanisms underlying these sequelae make them difficult to prevent and treat, often leading to chronic impairments in physical functioning and quality of life [4]. For example, highly burdensome health issues in AYAs like cancer-related cardiovascular disease [5], fatigue [6] and psychological distress [7] are known to be caused and influenced by interactions between cancer-, behavioural- and life stage-related physical and psychosocial factors [8–12]. Importantly, there is a growing body of evidence that multi-system interventions, like exercise, are among the most effective therapies to mitigate and reverse adverse effects associated with cancer and its treatment [13–15].

Indeed, a rapidly expanding evidence-base supports the benefits of exercise in cancer survivors [16]. However, comparatively few studies have been conducted in AYAs [17–24]; and, the findings of these studies provide inconsistent evidence of benefit. This relative dearth of evidence is problematic as AYAs have unique and well-recognized age- and life stage-related support needs, preferences, and barriers that may limit engagement in protective health behaviours such as exercise [25–27]. The lack of engagement and inconsistent benefits reported in the few AYA-focused exercise trials to date may reflect researchers’ incomplete understanding of AYAs’ exercise support needs and preferences and, relatedly, a failure to adapt their intervention approaches to account for these needs and preferences [25, 27].

Several previous studies have assessed the exercise and physical activity (hereafter, collectively referred to as PA) support needs, barriers and facilitators of AYAs [28–30]. However, the findings from these studies may have limited generalizability given the studies included samples that were not representative or not described according to age, diagnosis, ethnicity, sex or treatment status. Consideration of these factors in AYAs may be important as previous needs assessments in older cancer survivors have demonstrated that PA support preferences differ according to personal (e.g. sex, PA behaviour) and medical (e.g. receiving chemotherapy) characteristics [31, 32]. A better understanding of how these factors influence PA behaviour and preferences is needed to inform the development of AYA-tailored PA support services and optimize engagement with them.

Therefore, the primary purpose of this study was to characterise PA behaviour and support preferences in a representative sample of AYAs to inform the development of AYA-tailored PA research and clinical-/community-based support services. The secondary purpose of this survey was to expand upon the findings of similar needs assessments in cancer survivors by assessing novel PA preferences (e.g. program supervision and restrictions) and exploring PA preferences for select demographic (i.e. sex, relationship status), medical (e.g. treatment status), behavioural (i.e. current physical activity participation), and PA support location-specific AYA subgroups. These preferences and subgroup analyses were included to inform the development of targeted research and intervention approaches.

**Methods**

**Study design and eligibility**

A convenience sample of AYAs was recruited from Princess Margaret Cancer Centre (Toronto, ON) for this cross-sectional survey study. Study methods were approved by the University Health Network Research Ethics Board (#16-5083). This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (Online Resource 1). Participants were eligible if they had a confirmed history of cancer diagnosed between the ages of 18 and 39 years, irrespective of time since diagnosis, and could communicate in English, with or without assistance from a translator. Appointment lists from 11 hospital clinics (i.e. bone marrow transplant, breast, chemo/daycare, central nervous system, endocrine, gastrointestinal, genitourinary, gynecological, leukemia, lymphoma and sarcoma) were screened and potentially eligible participants were approached in clinic to confirm their eligibility and interest in participation. All eligible and interested participants reviewed the study details and signed informed consent with a study team member.

**Survey instrument**

Participants completed a self-administered survey consisting of validated questionnaires and investigator-developed items (further described below). The survey incorporated questions that reflect and complement items used to assess PA preferences within similar needs assessments of AYAs [28] and older cancer survivors [31, 33]. See Online Resource 2 for all analysis factors, scales and dichotomies.

**Participant characteristics**

**Demographic characteristics** AYAs’ age, sex, ethnicity, relationship status, body height and weight, residence community size and location (via postal code) were collected via self-report. Body height and weight were used to calculate and classify individuals according to body mass index (BMI). Demographic variables were dichotomized for sub-group analysis as sex (male vs. female), age (median split of younger
(<32 years) vs. older (≥32 years) and relationship status (single vs. in relationship).

**Medical characteristics** AYA’s date of diagnosis, diagnosis type, disease stage, cancer treatment status and cancer treatment history (when applicable) were self-reported. Medical variables were dichotomized for sub-group analysis as BMI classification (not obese (<30 kg/m²) vs. obese (≥32 kg/m²)), disease stage (earlier (stage 1 and 2) vs. later (stage 3 and 4)) and treatment status (current treatment vs. no/post-treatment).

**PA behaviour and facilitators**

**PA behaviour and history** PA engagement was measured via a commonly used modified version of the Godin Leisure Time Exercise Questionnaire (GLTEQ) [34]. Briefly, participants reported the average duration and frequency of light, moderate and vigorous PA within a typical seven-day period. The total number of moderate intensity PA minutes, vigorous intensity PA minutes and combined moderate-to-vigorous intensity PA minutes (MVPA; i.e. total moderate intensity minutes plus 2× vigorous intensity minutes) were calculated. Weekly MVPA levels were used to classify participants as being sedentary (no PA minutes per week), inactive (1–149 PA minutes per week) and active (meeting public health guidelines of ≥150 PA minutes per week) [35]. Current PA behaviour was dichotomized for sub-group analysis as not meeting guidelines (<150 min of MVPA per week) vs. meeting guidelines (≥150 min of MVPA per week). Participants were asked to describe their PA behaviour during childhood and adolescence as ‘Not active’, ‘A little active’ or ‘Very active’.

**PA facilitators** AYAs were asked to indicate whether they had access to a home gym or gym membership (Yes/No) and rate the degree to which they enjoy participating in PA alone and with others (5-point Likert, Not at all to Very much).

**PA support, program delivery and prescription preferences**

Participants’ PA preferences were assessed using investigator-developed questions with dichotomous, categorical or 5-item Likert response options.

**PA support interests and program delivery preferences**

Adapted from similar reviews [33, 36], we included PA support and program delivery items to inform the need for, and planning of, PA research and programs for AYAs. Questions related to interest in PA support (i.e. no, maybe, yes), PA behaviour goals (i.e. none, decrease, maintain, increase) and preferences towards the: (1) overall timing of PA support (e.g. before, during, after treatment); (2) weekly timing of PA support (i.e. none, weekday, weekend, both); (3) daily timing of PA support (e.g. morning, afternoon, evening); (4) PA support setting (e.g. hospital, home); (5) type of PA support supervision (e.g. individual, group); (6) sport participation (e.g. individual, team sports); and (7) restriction of program participation (e.g. by cancer type or sex).

**PA prescription preferences** PA prescription-related items were designed to guide research and clinical intervention planning by assessing AYAs’ preferred PA frequency (e.g. 1×/week, 2×/week), time (e.g. <10 min, 10–20 min) and type (modality: e.g. aerobic, resistance, flexibility).

**Sample size**

There was no primary outcome defined for this study. However, sample size was estimated using a between-groups comparison by sex of MVPA behaviour measured using the GLTEQ. Based on previous research [37, 38], with two groups of 176 male and female participants (total n = 352), we had 80% power to detect an effect size of d = 0.3 with significance set to p < 0.05.

**Statistical analyses**

Statistical analyses were performed using SPSS statistical software version 24 (IBM Corporation, Armonk, NY). Continuous and ordinal variables that could potentially influence PA behaviour and preferences were dichotomized for analysis purposes (Online Resource 2). Exploratory analyses were conducted to identify demographic and medical characteristics that were frequently associated with differences in PA support preferences between dichotomized sub-groups. Variables that were associated with significant (p < 0.05) sub-group specific differences in at least 20% of the assessed PA behavioural and support preference outcomes were included in the sub-group analyses. PA setting-specific support preferences (i.e. hospital, university/college, home, online) were also included in the sub-group analyses to inform the development of targeted research and support services.

Descriptive statistics (frequencies, percentages, means and standard deviations) were calculated for all categorical and continuous data, as appropriate. Student’s t tests and chi-square, and exact McNemar’s tests were used to assess between-group differences in means, percentages and proportions, respectively. Participants were excluded using an investigator-established cut-off of ≥ 40% missing data to facilitate PA comparisons. No additional missing data strategy (e.g. imputation) was used given that most items were independent and could not reliably be predicted. The Benjamini and Hochberg method [39, 40] was applied to each group of analyses to help limit the potential bias from multiple testing. Results are reported with uncorrected and corrected significance levels for each group of analyses.
Results

Participant characteristics

Three hundred and sixty-six of the 533 AYAs approached from June 2018 to September 2019 consented to participate. Forty-eight AYAs were excluded upon retrieval of the questionnaire (n = 16) and during data entry (n = 32) due to missing data (Fig. 1), resulting in a final sample of n = 318 AYAs (59% completion rate). AYAs’ demographic and medical characteristics are provided in Table 1. Four variables (i.e. sex, relationship status, treatment status and PA behaviour) had significant (p < 0.05) sub-group specific differences in over 20% of the assessed PA behavioural and support preference outcomes and were thus included in the sub-group analyses. Other subgroups (e.g. those defined according to age (<32 vs. ≥32 years), obesity status (BMI < 30 vs. ≥30 kg/m²) and childhood/adolescence PA behaviour (low vs. high)) were also explored but were not included in our subgroup analyses due to lack of observed differences in PA support, program delivery and prescription preferences.

PA behaviour and facilitators

Overall and subgroup-specific PA behaviour are reported in Tables 1 and 2. The majority of AYAs (n = 198; 62.3%) were meeting the PA guidelines [35] and reported a mean of 308.7 ± 298.0 min of MVPA per week. AYAs who identified as male and were not receiving treatment performed significantly greater levels of vigorous-intensity and MVPA (p ≤ 0.01; Table 2). Seventeen (5%) AYAs reported previous engagement in hospital- and community-based exercise support services for cancer survivors.

PA support, program delivery and prescription preferences

Complete overall and subgroup-specific PA support, program delivery and prescription preferences are provided in Fig. 2, Table 3 and Online Resources 3–6.

PA support interest and goals

The majority of AYAs reported an interest in receiving PA support (78.4%) and had an explicit goal of increasing their PA engagement (70.8%). The relative interest in PA support was greater in AYAs receiving treatment (87.0%) compared to those who were not (72.9%; p = 0.003).

PA support start preferences

A combined ~80% of AYAs reported preferring commencing exercise support in the post-treatment setting. A greater percentage of AYAs preferred commencing exercise support within the first-year post-treatment compared to other phases (p < 0.001). Compared to AYAs not receiving treatment, a greater percentage of AYAs receiving treatment were interested in starting PA support during treatment (30.4% vs. 9.6%; p < 0.001) and were less interested in starting PA support > 1-year post-treatment (3.4% vs. 25.3%; p < 0.001). The percentage of AYAs interested in receiving PA support during treatment was also greater in people with later vs. earlier stages of disease (28.6% vs. 9.7%; p = 0.001).

PA support setting and supervision preferences

Home-based (79%), online (47%) and university-/college-based (44%) exercise settings were all preferred more than hospital-based programs (25%; p < 0.001). A significantly greater proportion of AYAs preferred participating in programs that were supervised individually (82%) and combined (i.e. individual and group; 70%) rather than exclusively group-based (61%; p < 0.001).

Sports participation preferences

More respondents identified a preference for participating in individual (57%) versus team (50%) sports (p = 0.02) and recreational (57%) versus competitive (36%) sports (p < 0.001). Compared to females, a significantly greater percentage of males reported preferring most types of sports participation (p < 0.001), except for recreational sports.

PA program restriction preferences

Greater percentages of AYAs reported a preference for participating in PA programs that were (1) age-specific (63%) compared to programs that were restricted by cancer type (47%), sex (48%), and both age and sex (48%; p < 0.001), and (2) inclusive of cancer survivors (50%) rather than being restricted to cancer survivors (45%; p = 0.02). Identifying as female was most consistently associated with preferring participation in PA programs restricted to cancer type, sex, age and sex, and cancer survivors.

PA prescription preferences

The majority (≥75%) of AYAs preferred performing ≥30 min of exercise on ≥3 days per week. Compared to those who were inactive, a greater percentage of AYAs who were active preferred ≥3 days per week (p = 0.003) and ≥30 min of exercise per session (p < 0.001).

The percentage of AYAs preferring strength training (82.6%), walking (78.3%) and flexibility (74.7%) was greater than all other exercise modalities (p < 0.001). Compared to all other exercise modalities, boot camp-based exercise was
the least preferred (37%; \(p < 0.001\)). A greater percentage of females than males reported preference towards multiple individual exercise modalities, including boot camps (\(p = 0.01\)), flexibility (\(p < 0.01\)), walking (\(p < 0.001\)) and yoga (\(p < 0.001\)). Yoga was preferred by greater percentages of AYAs who were receiving treatment (\(p = 0.002\)), compared to those who were not.

**Setting-specific PA preferences**

Complete setting-specific preferences are provided in Online Resources 3–6. AYAs preferring public (i.e. hospital and university/college) PA support were interested in programs with a group-based component delivered either as (1) combined individual- and group-based support (hospital: 87% vs. 64%; university/college: 88% vs. 55%) or (2) exclusively group-based (hospital: 83% vs. 53%; university/college: 79% vs. 46%); while, AYAs preferring private (i.e. home and online) PA support were interested in individual programs (home: 88% vs. 63%; online: 90% vs. 75%). AYAs interested in public, but not private, PA support preferred participating in sports at recreational (hospital: 81% vs. 48%; university/college: 77% vs. 41%) and competitive (hospital: 55% vs. 30%; university/college: 54% vs. 21%) levels. Finally, unlike AYAs interested in private support, greater percentages of AYAs interested in public PA support preferred specific modalities of exercise.

**Discussion**

This study provides important insight into AYAs’ overall and subgroup-specific PA preferences to facilitate AYA-tailored PA research and enhance supportive care programming. AYAs report a great interest and capacity to engage in PA, particularly if interventions incorporate home-based training, individual supervision, and include strength, walking, and flexibility exercise components. Our subgroup analyses revealed that PA support preferences in AYAs most often differed on the basis of sex, treatment status, current PA behaviour and preferred support setting—highlighting the need to tailor PA interventions when working within specific contexts. Finally, our finding that only 5% of AYAs had engaged with local cancer PA support services is particularly striking given AYAs’ great interest in PA support and that our sample was recruited from one of the few cancer centres in the province with dedicated cancer PA support programming [41].

These seemingly incongruous findings suggest that existing cancer PA support services may not be well-aligned with the unique needs and preferences of AYAs [25].
Table 1 Demographic and medical profile of participants overall and by sex

| Participant characteristics | Overall (n = 318) | Males (n = 174) | Females (n = 144) | p* |
|-----------------------------|------------------|-----------------|------------------|----|
|                             | No. of patients  | %               | No. of patients  | %  | No. of patients  | %  |
| **Demographic profile**     |                  |                 |                  |    |
| Age, years                  |                  |                 |                  |    |
| Mean (SD)                   | 32.0 (6.6)       | 31.5 (7.4)      | 32.7 (5.5)       | 0.12 |
| Range                       | 18–68            | 18–68           | 18–39            |     |
| Ethnicity                   |                  |                 |                  |    |
| Caucasian                   | 190              | 59.7            | 118              | 67.8 | 72              | 50.0 | 0.001 |
| Southeast Asian             | 49               | 15.4            | 21               | 12.1 | 28              | 19.4 | 0.07  |
| East Asian                  | 24               | 7.5             | 11               | 6.3  | 13              | 9.0  | 0.36  |
| Latino/Latina               | 12               | 3.8             | 6                | 3.4  | 6               | 4.2  | 0.74  |
| Middle Eastern              | 9                | 2.8             | 4                | 2.3  | 5               | 3.5  | 0.53  |
| West Asian                  | 8                | 2.5             | 4                | 2.3  | 4               | 2.8  | 0.79  |
| Black                       | 8                | 2.5             | 2                | 1.1  | 6               | 4.2  | 0.09  |
| West Indian                 | 4                | 1.3             | 3                | 1.7  | 1               | 0.7  | 0.41  |
| Native American             | 2                | 0.6             | 2                | 1.1  | 0               | 0.0  | 0.20  |
| Not reported                | 12               | 3.8             | 3                | 1.7  | 9               | 6.3  |     |
| Relationship status         |                  |                 |                  |    |
| Single                      | 105              | 33.1            | 65               | 37.4 | 40              | 27.8 | 0.07  |
| Relationship, not living with| 45              | 14.2            | 23               | 13.2 | 22              | 15.3 | 0.60  |
| Married/living with partner | 167              | 52.7            | 85               | 48.9 | 82              | 56.9 | 0.15  |
| Residence community size†   |                  |                 |                  |    |
| Large urban centres         | 189              | 59.4            | 97               | 55.7 | 92              | 63.9 | 0.14  |
| Medium population centres   | 22               | 6.9             | 17               | 9.8  | 5               | 3.5  | 0.03  |
| Small population centres    | 14               | 4.4             | 9                | 5.2  | 5               | 3.5  | 0.46  |
| Not reported                | 93               | 29.2            | 51               | 29.3 | 42              | 29.2 |     |
| **Medical profile**         |                  |                 |                  |    |
| Weight (kg)                 |                  |                 |                  |    |
| Mean (SD)                   | 77.1 (18.9)      | 83.4 (17.1)     | 69.5 (18.3)      | < 0.001 |
| BMI, kg/m²                  |                  |                 |                  |    |
| Mean (SD)                   | 25.9 (5.3)       | 26.1 (4.7)      | 25.6 (6.0)       | 0.39  |
| BMI classification           |                  |                 |                  |    |
| Underweight                 | 12               | 3.8             | 4                | 2.3  | 8               | 5.6  | 0.13  |
| Normal weight               | 145              | 45.6            | 71               | 40.8 | 74              | 51.4 | 0.06  |
| Overweight                  | 92               | 28.9            | 63               | 36.2 | 29              | 20.1 | 0.002 |
| Obese                       | 62               | 19.4            | 32               | 18.4 | 30              | 20.8 | 0.58  |
| Not reported                | 7                | 2.2             | 4                | 2.3  | 3               | 2.1  |     |
| Time since diagnosis (months)|                  |                 |                  |    |
| Mean (SD)                   | 39.6 (52.1)      | 46.6 (59.4)     | 31.3 (40.7)      | 0.01  |
| Range                       | 0–478            | 1–478           | 0–224            |     |
| Disease stage               |                  |                 |                  |    |
| Stage 1                     | 82               | 25.8            | 51               | 29.3 | 31              | 21.5 | 0.11  |
| Stage 2                     | 55               | 17.3            | 24               | 13.8 | 31              | 21.5 | 0.07  |
| Stage 3                     | 48               | 15.1            | 24               | 13.8 | 24              | 16.7 | 0.48  |
| Stage 4                     | 22               | 6.9             | 10               | 5.7  | 12              | 8.3  | 0.37  |
| Unsure                      | 102              | 32.1            | 63               | 36.2 | 39              | 27.1 |     |
| Not reported                | 9                | 2.8             | 2                | 1.1  | 7               | 4.9  |     |
| Disease type                |                  |                 |                  |    |
| Urological                  | 130              | 40.9            | 128              | 73.6 | 2               | 1.4  | < 0.001 |
Compared to prior PA needs assessments in AYAs, our results indicate that similar percentages of AYAs prefer participating in PA programming that is age-restricted [28, 29] but that greater percentages of AYAs are meeting PA guidelines [28, 29], interested in PA support [28], want to further increase PA levels [28], and prefer home- and hospital-based [28] support. Our findings also suggest that AYAs’ PA behaviour and support needs are different from older cancer survivors. For example, indirect comparisons with the findings of PA needs assessments in older cancer survivors most often reveal that a greater proportion of AYAs are: (1) meeting PA guidelines, (2) want PA support, (3) want to increase their PA levels, and prefer interventions that are (4) individually supervised, (5) home- and hospital-based, (6) include resistance training and flexibility exercise, and (7) are offered in the evenings [31, 36, 42]. These findings are particularly revealing within our local context. To our knowledge, at the time of this survey, the cancer PA support services offered within the study’s sampling region (e.g. CaRE [43] and Wellspring [44]) were (1) exclusively facility-based, (2) delivered in a group, (3) offered during the day, (4) open to all ages of adult cancer survivors and (5) likely not providing adequate options for resistance training. Overall, our data confirm previous assertions [25, 30] that AYAs have...

Table 1 (continued)

| Participant characteristics | Overall (n = 318) | Males (n = 174) | Females (n = 144) | p* |
|-----------------------------|------------------|----------------|------------------|----|
| No. of patients | % | No. of patients | % | No. of patients | % |
| Hematological | 59 | 18.6 | 29 | 16.7 | 30 | 20.8 | 0.34 |
| Breast | 38 | 11.9 | 0 | 0.0 | 38 | 26.4 | < 0.001 |
| Gynecological | 34 | 10.7 | - | - | 34 | 23.6 | < 0.001 |
| Head and neck | 20 | 6.3 | 1 | 0.6 | 22 | 13.2 | < 0.001 |
| Sarcoma | 18 | 5.7 | 10 | 5.7 | 8 | 5.6 | 0.94 |
| Gastrointestinal | 9 | 2.8 | 4 | 2.3 | 5 | 3.5 | 0.53 |
| Skin | 6 | 1.9 | 1 | 0.6 | 5 | 3.5 | 0.06 |
| CNS/neuroendocrine | 4 | 1.3 | 1 | 0.6 | 3 | 2.1 | 0.23 |
| Treatment status | | | | | |
| Currently receiving treatment | 124 | 39.0 | 49 | 28.2 | 75 | 52.1 | < 0.001 |
| Treatment exposure** | | | | | |
| Surgery | 192 | 60.4 | 113 | 68.5 | 79 | 57.7 | 0.05 |
| Chemotherapy | 206 | 64.8 | 124 | 75.2 | 82 | 59.9 | 0.004 |
| High-dose chemotherapy | 38 | 11.9 | 21 | 12.7 | 17 | 12.4 | 0.93 |
| Radiotherapy | 74 | 23.3 | 26 | 15.8 | 48 | 35.0 | < 0.001 |
| Stem cell | 20 | 6.3 | 17 | 10.3 | 3 | 2.2 | 0.005 |
| Other | 25 | 7.9 | 6 | 3.6 | 19 | 13.9 | 0.001 |
| PA profile | | | | | |
| Meeting PA guidelines | 198 | 62.3 | 122 | 70.1 | 76 | 52.8 | 0.001 |
| PA history | | | | | |
| Very active during childhood | 268 | 84.3 | 148 | 86.0 | 120 | 83.3 | 0.50 |
| Very active during adolescence | 233 | 73.3 | 132 | 76.7 | 101 | 70.6 | 0.22 |
| PA facilitators | | | | | |
| Home gym | 126 | 39.6 | 72 | 41.4 | 54 | 38.3 | 0.58 |
| Gym membership | 128 | 40.3 | 71 | 40.8 | 57 | 40.7 | 0.99 |
| Enjoy PA alone | 221 | 69.5 | 130 | 76.5 | 91 | 65.0 | 0.03 |
| Enjoy PA with others | 178 | 56.0 | 105 | 60.7 | 73 | 52.9 | 0.17 |
| Cancer PA program participation | 17 | 5.3 | 5 | 2.9 | 12 | 8.4 | 0.03 |

Notes: BMI, body mass index; CNS, central nervous system; PA, physical activity; kg, kilograms; m, meter; No., number; SD, standard deviation
†Population centre sizes: large (n ≥ 100,000), medium (n = 30,000 to 99,999), small (n = 1000 to 29,999)
*Italicized p values reflect those that remained significant following Benjamini and Hochberg correction with a calculated significance threshold set to p < 0.011
**Total percentage exceeds 100% due to multiple treatment exposures

Compared to prior PA needs assessments in AYAs, our results indicate that similar percentages of AYAs prefer participating in PA programming that is age-restricted [28, 29] but that greater percentages of AYAs are meeting PA guidelines [28, 29], interested in PA support [28], want to further increase PA levels [28], and prefer home- and hospital-based [28] support. Our findings also suggest that AYAs’ PA behaviour and support needs are different from older cancer survivors. For example, indirect comparisons with the findings of PA needs assessments in older cancer survivors most often reveal that a greater proportion of AYAs are: (1) meeting PA guidelines, (2) want PA support, (3) want to increase their PA levels, and prefer interventions that are (4) individually supervised, (5) home- and hospital-based, (6) include resistance training and flexibility exercise, and (7) are offered in the evenings [31, 36, 42]. These findings are particularly revealing within our local context. To our knowledge, at the time of this survey, the cancer PA support services offered within the study’s sampling region (e.g. CaRE [43] and Wellspring [44]) were (1) exclusively facility-based, (2) delivered in a group, (3) offered during the day, (4) open to all ages of adult cancer survivors and (5) likely not providing adequate options for resistance training. Overall, our data confirm previous assertions [25, 30] that AYAs have...
Table 2  PA engagement overall and by demographic, medical, PA experience, PA interests and PA facilitators subgroups

| Participant characteristics | n     | Moderate-intensity PA minutes | Vigorous-intensity PA minutes | Total MVPA* minutes |
|----------------------------|-------|-------------------------------|-------------------------------|---------------------|
|                            |       | Mean  | SD     | Diff.                | 95% CI | p      | Mean  | SD     | Diff.                | 95% CI | p      | Mean  | SD     | Diff.                | 95% CI | p      |
| Overall                    | 318   | 110.9 | 127.8 |                      |        |        | 99.1  | 122.8 |                      |        |        | 308.7 | 298.0 |                      |        |        |
| Demographic factors        |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Sex                        |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Male                       | 174   | 117.0 | 132.1 | 13.5                | −14.9 to 41.9 | 0.35  | 128.8 | 139.5 | 65.5                | 40.3−90.7 | < 0.001 | 374.5 | 323.5 | 145.2                | 82.7−207.7 | < 0.001   |
| Female                     | 143   | 103.5 | 122.5 |                      |        |        | 63.3  | 86.7  |                      |        |        | 229.3 | 242.1 |                      |        |        |
| Age (mean split)           |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Younger (< 32 years)       | 133   | 106.2 | 122.4 | −8.8                | −37.6 to 20.0 | 0.55  | 112.4 | 125.5 | 22.1                | −5.4 to 49.7 | 0.11   | 330.2 | 303.7 | 34.7                | −32.2 to 101.6 | 0.31     |
| Older (≥ 32 years)         | 183   | 115.0 | 132.2 |                      |        |        | 90.2  | 120.7 |                      |        |        | 295.5 | 294.4 |                      |        |        |
| Relationship status        |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Single                     | 105   | 110.5 | 117.0 | −0.04               | −30.2 to 30.1 | 0.99  | 125.0 | 130.6 | 38.2                | 8.5−67.9 | 0.01   | 359.3 | 313.5 | 75.3                | 5.6−144.9 | 0.03     |
| In relationship            | 212   | 110.5 | 133.1 |                      |        |        | 86.8  | 117.1 |                      |        |        | 284.1 | 288.1 |                      |        |        |
| Medical factors            |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Obesity status             |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Not obese                  | 249   | 115.6 | 130.1 | 22.1                | −14.0 to 58.3 | 0.23  | 104.4 | 127.0 | 30.1                | −4.1 to 64.2 | 0.09   | 324.4 | 308.4 | 83.7                | 0.7−166.8 | < 0.05    |
| Obese                      | 62    | 93.5  | 121.9 |                      |        |        | 74.4  | 101.3 |                      |        |        | 240.7 | 248.4 |                      |        |        |
| Treatment status           |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| No Tx/post Tx              | 194   | 131.9 | 144.9 | 53.9                | 28.3−79.4 | < 0.001 | 117.9 | 132.2 | 48.2                | 22.5−73.9 | < 0.001 | 367.1 | 320.8 | 149.6                | 88.6−210.7 | < 0.001   |
| Current Tx                 | 124   | 78.1  | 86.2  |                      |        |        | 69.7  | 100.0 |                      |        |        | 217.5 | 231.4 |                      |        |        |
| PA experience              |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Childhood PA behaviour     |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Low                        | 48    | 80.6  | 98.1  | −36.2               | −68.6 to −3.7 | 0.03  | 109.0 | 131.3 | 11.8                | −26.1 to 49.7 | 0.54   | 298.5 | 295.1 | 12.2                | −104.4 to 80.0 | 0.80     |
| High                       | 268   | 116.8 | 132.1 |                      |        |        | 97.2  | 121.4 |                      |        |        | 310.8 | 299.6 |                      |        |        |
| Adolescent PA behaviour    |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| Low                        | 82    | 118.0 | 151.4 | 8.9                 | −23.6 to 41.3 | 0.59  | 78.8  | 98.2  | −27.6               | −54.8 to −0.4 | < 0.05 | 275.6 | 283.0 | 45.9                | −121.3 to 29.6 | 0.23     |
| High                       | 233   | 109.1 | 119.2 |                      |        |        | 106.4 | 129.9 |                      |        |        | 321.4 | 303.8 |                      |        |        |
| PA interests and facilitators|     |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| PA support interest        |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| No                         | 68    | 139.0 | 149.0 | 35.3                | −3.9 to 74.6 | 0.08  | 115.0 | 149.2 | 19.5                | −13.7 to 52.6 | 0.25   | 367.0 | 359.3 | 72.2                | −21.2 to 165.7 | 0.13     |
| Yes                        | 247   | 103.6 | 121.0 |                      |        |        | 95.6  | 114.9 |                      |        |        | 294.8 | 278.8 |                      |        |        |
| PA goals                   |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| No PA increase             | 90    | 119.7 | 147.4 | 12.9                | −18.6 to 44.4 | 0.42  | 139.6 | 159.1 | 56.4                | 20.6−92.3 | 0.002  | 398.8 | 369.0 | 126.2                | 41.9−210.5 | 0.004    |
| PA increase                | 218   | 106.8 | 118.5 |                      |        |        | 83.2  | 100.7 |                      |        |        | 272.6 | 255.9 |                      |        |        |
| Home gym access            |       |       |       |                      |        |        |       |       |                      |        |        |       |       |                      |        |        |
| No                         | 189   | 95.0  | 109.1 | −39.8               | −70.4 to −9.2 | 0.01  | 85.2  | 112.1 | −35.0               | −62.5 to −7.4 | 0.01   | 265.5 | 268.0 | −108.7               | −177.7 to −39.7 | 0.002    |
| Yes                        | 189   | 139.0 | 149.0 | 35.3                | −3.9 to 74.6 | 0.08  | 115.0 | 149.2 | 19.5                | −13.7 to 52.6 | 0.25   | 367.0 | 359.3 | 72.2                | −21.2 to 165.7 | 0.13     |
distinct support needs and preferences from older cancer survivors and provide direction for tailoring AYA-focused PA research and program development.

To our knowledge, this is the first study to assess the effects of preferred PA support setting on PA support and prescription preferences in any cancer survivor group. Compared to individuals preferring private (i.e. home-based or online) PA support, AYAs preferring public (i.e. hospital or university/college-based) PA support indicated strong preferences towards programming that included a group supervision component, a sport component, strength and flexibility exercise, and that was restricted to similar others (e.g. restricted by age or exclusive to cancer survivors). These findings are particularly salient for clinicians and researchers developing and delivering remote monitored exercise interventions to AYAs preferring in-person PA support in the era of COVID-19. Specifically, to optimize recruitment and retention, our findings suggest that clinicians and researchers may benefit from (1) pre-screening program and study participants to identify individuals preferring in-person PA support and (2) preemptively adapting their distance-based intervention approaches to reflect and accommodate the PA preferences of these AYAs.

Finally, exercise is emerging as a promising clinical therapy to prevent and mitigate cancer and treatment-related late effects in cancer survivors [13–15] and may be an attractive non-pharmacological therapy to protect vulnerable groups of AYAs. Few studies, however, have assessed the potential benefits of exercise therapy in AYAs to date [17–24]. Unfortunately, these studies provide inconsistent evidence of health benefits potentially due to their diverse aims (e.g. assessing the feasibility of distance-based delivery methods) [22, 23], scope (e.g. behaviour change) [18, 22, 23], methodological issues (e.g. inadequate power) [18, 23] and, based on our findings, poor alignment with AYAs’ PA support preferences (e.g. no strength training or flexibility components) [18, 22, 23]. These findings are in contrast to two more recent trials involving supervised, individually tailored and rigorously prescribed (i.e. adherent to principles of exercise prescription [45]) exercise interventions that produced significant improvements in physical [17, 21] and psychosocial [24] outcomes in AYAs. These mixed results highlight the need for rigorous exercise and physical activity research in AYAs. To this end, our findings can be used to support the development and testing of exercise and physical activity interventions that reflect AYAs’ unique overall- and subgroup-specific support preferences and, ultimately, support the development of evidence-based clinical and community support services for them.

This study adds to the evidence base by confirming, extending and contrasting with the findings of previous PA needs assessments in oncology. First, our PA preference findings may be more generalizable than related AYA-specific

| Table 2 (continued) |  |
|---------------------|-----------------------------|
| Participant characteristics |  |
| n | Mean | SD | Diff. | 95% CI | p  |
|  |  |  |  |  |  |
| Total MVPA minutes | 124 | 134.8 | 149.3 | 120.2 | 134.9 | 374.1 | 326.6 | 0.0001 |  |  |
| Moderate-intensity PA minutes | 124 | 101.8 | 123.7 | 112.7 | 123.4 | 60.8 | 80.0 | 0.12 | 0.09 | 0.99 | 0.01 | 0.01 |  |  |
| Vigorous-intensity PA minutes | 124 | 124.5 | 133.4 | 145.0 | 155.7 | 50.6 | 80.3 | 0.14 | 0.01 | 0.001 | 0.001 | 0.001 | 0.001 |  |  |
| Notes: |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| CI, confidence interval; mins, minutes; MVPA, moderate-to-vigorous intensity physical activity; PA, physical activity; SD, standard deviation; Tx, treatment |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Total MVPA minutes calculated as 2 × vigorous-intensity minutes + moderate-intensity minutes |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Italicized p values reflect those that remained significant following Benjamini and Hochberg correction with a calculated significance threshold set to p < 0.023 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
studies given that our data were obtained from one of the largest and arguably the most representative (e.g. sex, cancer type, treatment status, time since diagnosis) sample of AYAs surveyed to date. Second, our findings provide novel insight to support the tailoring of future AYA-specific PA research and support services by: (1) highlighting numerous, and potentially important, differences in PA support preferences between AYAs and older survivors; (2) focusing on preferences for PA program delivery and exercise prescription, rather than PA counselling; and, (3) exploring the associations between PA behaviour and preferences and novel demographic, medical, and behavioural moderators.

Fig. 2 Panels A–F: physical activity (PA) support preferences in AYA cancer survivors. Panel A) Preferred timing of PA support start. Notes: Dx, diagnosis; Tx, treatment; a ps < 0.001 relative to all other groups; b ps = 0.007 relative to Immediately post-Dx; c ps = 0.04 relative to Immediately post-Dx. Panel B) Preferred location of PA support. Notes: a ps < 0.001 relative to all other groups; b ps < 0.001 relative to Hospital. Panel C) Preferred type of PA program supervision. Notes: a ps < 0.001 relative to all other types; b ps < 0.001 relative to Group programs. Panel D) Preferred characteristics of sports participation. Notes: a ps = 0.02 relative to Team sports; b ps < 0.001 relative to Competitive sports. Panel E) Preferred PA program participation restrictions. Notes: a ps < 0.001 relative to all other groups; b ps = 0.02 relative to Survivor restricted. Panel F) Preferred modality of PA support. Notes: a ps < 0.001 relative to all other groups (except walking; p = not significant); b ps < 0.001 relative to Aerobic, Yoga, Circuit training and Boot camp; c ps ≤ 0.01 relative to Circuit training and Boot camp; d ps < 0.001 relative to Boot camp. *p values reflect those that remained significant following Benjamini and Hochberg correction with calculated significance thresholds set to: Panel A) PA support start (p < 0.029); Panel B) PA location (p < 0.036); Panel C) type of PA supervision (p < 0.038); Panel D) sports preference (p < 0.033); Panel E) PA support timing within week (p < 0.029); Panel F) PA modality (p < 0.039)
| Outcomes | Overall | Demographic, medical and behavioural subgroup preferences | p* |
|----------|---------|--------------------------------------------------------|----|
| PA support interests and program delivery preferences | | | |
| PA program support interesta | 247 78.4 | Sex Male 128 74.4 Female 119 83.2 0.06 | |
| n = 315 respondents | In relationship No 89 85.6 Yes 158 75.2 0.04 | | |
| | On treatment No 140 72.9 Yes 107 87.0 0.003 | | |
| | Physically active No 94 79.7 Yes 153 77.7 0.68 | | |
| Increase current PA (goal)b | 218 70.8 | Sex Male 117 69.2 Female 101 72.7 0.51 | |
| n = 308 respondents | In relationship No 72 70.6 Yes 146 71.2 0.91 | | |
| | On treatment No 131 68.9 Yes 87 73.7 0.37 | | |
| | Physically active No 83 72.2 Yes 135 69.9 0.68 | | |
| PA support startc | | | |
| After diagnosis | 31 10.4 | Sex Male 15 9.4 Female 16 11.7 0.52 | |
| n = 297 respondents | In relationship No 7 7.0 Yes 24 12.2 0.17 | | |
| | On treatment No 19 10.7 Yes 12 10.1 0.87 | | |
| | Physically active No 3 2.7 Yes 28 15.1 0.001 | | |
| During treatment | 53 17.8 | Sex Male 23 14.4 Female 30 21.9 0.09 | |
| n = 297 respondents | In relationship No 17 10.0 Yes 36 18.3 0.79 | | |
| | On treatment No 17 9.6 Yes 36 30.3 < 0.001 | | |
| 1st year post-treatment | 187 63.0 | Sex Male 101 63.1 Female 86 62.8 0.95 | |
| n = 297 respondents | In relationship No 67 67.0 Yes 120 60.9 0.31 | | |
| | On treatment No 114 64.0 Yes 73 61.3 0.64 | | |
| | Physically active No 72 64.3 Yes 115 62.2 0.71 | | |
| ≥ 1st year post-treatment | 49 16.5 | Sex Male 32 20.0 Female 17 12.4 0.08 | |
| n = 297 respondents | In relationship No 16 16.0 Yes 33 16.8 0.87 | | |
| | On treatment No 45 25.3 Yes 4 3.4 < 0.001 | | |
| | Physically active No 25 22.3 Yes 24 13.0 0.04 | | |
| PA program settingd | | | |
| Hospital | 77 25.0 | Sex Male 39 23.1 Female 38 27.3 0.39 | |
| n = 308 respondents | In relationship No 26 26.3 Yes 51 24.5 0.74 | | |
| | On treatment No 49 26.1 Yes 28 23.3 0.59 | | |
| | Physically active No 29 25.0 Yes 48 25.0 0.99 | | |
| University/College | 134 44.1 | Sex Male 77 45.6 Female 57 42.2 0.56 | |
| n = 304 respondents | In relationship No 55 55.0 Yes 79 38.9 0.008 | | |
| | On treatment No 86 46.0 Yes 48 41.0 0.40 | | |
| | Physically active No 41 36.6 Yes 93 48.4 < 0.05 | | |
| Home | 243 78.9 | Sex Male 128 74.0 Female 115 85.2 0.02 | |
| n = 308 respondents | In relationship No 73 74.5 Yes 170 81.3 0.17 | | |
| | On treatment No 143 74.9 Yes 100 85.5 0.03 | | |
| | Physically active No 91 81.3 Yes 152 77.6 0.44 | | |
| Online | 145 46.8 | Sex Male 64 37.2 Female 81 58.7 < 0.001 | |
| n = 310 respondents | In relationship No 51 49.5 Yes 94 45.6 0.52 | | |
| | On treatment No 87 45.5 Yes 58 48.7 0.58 | | |
| | Physically active No 60 52.2 Yes 85 43.6 0.14 | | |
| PA program timing | | | |
| Within week | | | |
| No preference | 147 46.2 | Sex Male 83 47.7 Female 64 44.4 0.56 | |
| n = 318 respondents | In relationship No 50 47.6 Yes 96 45.3 0.70 | | |
| | On treatment No 91 46.9 Yes 56 45.2 0.76 | | |
| | Physically active No 56 46.7 Yes 91 46.0 0.90 | | |
| Weekday | 75 23.6 | Sex Male 54 31.0 Female 21 14.6 0.001 | |
| n = 318 respondents | In relationship No 26 24.8 Yes 49 23.1 0.75 | | |
| | On treatment No 53 27.3 Yes 22 17.7 0.05 | | |
| | Physically active No 21 17.5 Yes 54 27.3 < 0.05 | | |
| Weekend | 114 35.8 | Sex Male 47 27.0 Female 67 46.5 0.001 | |
| n = 318 respondents | In relationship No 36 34.3 Yes 78 36.8 0.66 | | |
| | On treatment No 63 32.5 Yes 51 41.1 0.12 | | |
| | Physically active No 47 39.2 Yes 67 33.8 0.34 | | |
| Within dayf | | | |
| Morning | 134 42.1 | Sex Male 68 39.1 Female 66 45.8 0.23 | |
| n = 318 respondents | In relationship No 47 44.8 Yes 87 41.0 0.53 | | |
| | On treatment No 81 41.8 Yes 53 42.7 0.86 | | |
| | Physically active No 44 36.7 Yes 90 45.5 0.13 | | |
| Afternoon | 59 18.6 | Sex Male 33 19.0 Female 26 18.1 0.84 | |
Table 3 (continued)

| Outcomes | Overall | Demographic, medical and behavioural subgroup preferences | p* |
|----------|---------|--------------------------------------------------------|----|
|          | n = 318 respondents |                        |    |
| n = 318 respondents | | | |
| n = 318 respondents | In relationship | No | 24 | 22.9 | Yes | 35 | 16.5 | 0.17 |
| On treatment | No | 29 | 14.9 | Yes | 30 | 24.0 | 0.04 |
| Physically active | No | 21 | 17.5 | Yes | 38 | 19.2 | 0.71 |
| Sex | Male | 82 | 47.1 | Female | 61 | 42.4 | 0.40 |
| In relationship | No | 55 | 52.4 | Yes | 87 | 41.0 | 0.06 |
| On treatment | No | 96 | 49.5 | Yes | 47 | 37.9 | 0.04 |
| Physically active | No | 54 | 45.0 | Yes | 89 | 44.9 | 0.99 |
| PA program/participant supervision | | | |
| Individual exercise | 260 | 82.3 | Sex | Male | 142 | 81.6 | Female | 118 | 83.1 | 0.73 |
| n = 318 respondents | In relationship | No | 89 | 56.5 | Yes | 171 | 81.0 | 0.32 |
| On treatment | No | 160 | 82.5 | Yes | 100 | 82.0 | 0.91 |
| Physically active | No | 97 | 81.5 | Yes | 163 | 82.7 | 0.78 |
| Sex | Male | 102 | 58.6 | Female | 92 | 46.4 | 0.26 |
| In relationship | No | 72 | 69.2 | Yes | 122 | 57.8 | 0.05 |
| On treatment | No | 116 | 59.8 | Yes | 78 | 63.9 | 0.46 |
| Physically active | No | 69 | 58.0 | Yes | 125 | 63.3 | 0.33 |
| Group exercise | 194 | 61.4 | Sex | Male | 57 | 33.7 | Female | 32 | 22.0 | 0.04 |
| n = 316 respondents | In relationship | No | 81 | 71.1 | Yes | 139 | 66.8 | 0.04 |
| On treatment | No | 128 | 67.0 | Yes | 92 | 75.4 | 0.11 |
| Physically active | No | 82 | 68.9 | Yes | 138 | 71.1 | 0.68 |
| Varsity athlete mentored | 89 | 28.9 | Sex | Male | 57 | 33.7 | Female | 32 | 22.0 | 0.04 |
| n = 308 respondents | In relationship | No | 40 | 39.2 | Yes | 49 | 23.9 | 0.005 |
| On treatment | No | 59 | 31.4 | Yes | 30 | 15.0 | 0.23 |
| Physically active | No | 21 | 18.4 | Yes | 68 | 35.1 | 0.002 |
| Sport participation | | | |
| Individual sports | 172 | 56.6 | Sex | Male | 113 | 66.5 | Female | 59 | 44.0 | < 0.001 |
| n = 304 respondents | In relationship | No | 58 | 56.3 | Yes | 113 | 56.5 | 0.98 |
| On treatment | No | 106 | 57.0 | Yes | 66 | 55.9 | 0.86 |
| Physically active | No | 57 | 50.0 | Yes | 115 | 60.5 | 0.07 |
| Team sports | 149 | 49.5 | Sex | Male | 101 | 60.5 | Female | 48 | 35.8 | < 0.001 |
| n = 301 respondents | In relationship | No | 53 | 52.5 | Yes | 95 | 47.7 | 0.44 |
| On treatment | No | 98 | 53.6 | Yes | 51 | 43.2 | 0.08 |
| Physically active | No | 49 | 43.4 | Yes | 100 | 53.2 | 0.10 |
| Recreational sports | 176 | 57.1 | Sex | Male | 104 | 60.8 | Female | 72 | 52.6 | 0.15 |
| n = 308 respondents | In relationship | No | 61 | 59.8 | Yes | 115 | 56.1 | 0.54 |
| On treatment | No | 115 | 61.2 | Yes | 61 | 50.8 | 0.07 |
| Physically active | No | 65 | 55.6 | Yes | 111 | 58.1 | 0.66 |
| Competitive sports | 111 | 36.2 | Sex | Male | 78 | 46.2 | Female | 33 | 23.9 | < 0.001 |
| n = 307 respondents | In relationship | No | 47 | 46.1 | Yes | 64 | 31.4 | 0.01 |
| On treatment | No | 78 | 41.9 | Yes | 33 | 27.3 | 0.009 |
| Physically active | No | 26 | 23.0 | Yes | 85 | 43.8 | < 0.001 |
| PA program restriction | | | |
| Cancer type specific | 146 | 46.5 | Sex | Male | 67 | 38.7 | Female | 79 | 56.0 | 0.002 |
| n = 314 respondents | In relationship | No | 46 | 43.8 | Yes | 100 | 48.1 | 0.48 |
| On treatment | No | 77 | 40.5 | Yes | 69 | 55.6 | 0.009 |
| Physically active | No | 60 | 50.8 | Yes | 86 | 42.9 | 0.23 |
| Age-specific | 196 | 62.6 | Sex | Male | 106 | 61.6 | Female | 90 | 62.8 | 0.69 |
| n = 313 respondents | In relationship | No | 75 | 71.4 | Yes | 121 | 58.5 | 0.03 |
| On treatment | No | 117 | 61.6 | Yes | 79 | 64.2 | 0.64 |
| Physically active | No | 74 | 63.2 | Yes | 122 | 62.2 | 0.86 |
| Sex specific | 150 | 47.9 | Sex | Male | 64 | 37.4 | Female | 86 | 60.6 | < 0.001 |
| n = 313 respondents | In relationship | No | 47 | 45.2 | Yes | 103 | 49.5 | 0.47 |
| On treatment | No | 88 | 46.6 | Yes | 62 | 50.0 | 0.55 |
| Physically active | No | 57 | 48.3 | Yes | 93 | 47.7 | 0.92 |
| Age and sex specific | 150 | 47.9 | Sex | Male | 70 | 40.9 | Female | 80 | 56.3 | 0.007 |
| n = 313 respondents | In relationship | No | 51 | 48.6 | Yes | 99 | 47.8 | 0.90 |
| On treatment | No | 86 | 45.5 | Yes | 64 | 51.6 | 0.29 |
| Physically active | No | 55 | 47.0 | Yes | 95 | 48.5 | 0.80 |
| Exclusive to survivors | 141 | 44.9 | Sex | Male | 69 | 39.9 | Female | 72 | 51.1 | < 0.05 |
| n = 314 respondents | In relationship | No | 51 | 48.6 | Yes | 90 | 43.3 | 0.37 |
| On treatment | No | 81 | 42.4 | Yes | 60 | 48.8 | 0.27 |
| Physically active | No | 58 | 49.2 | Yes | 83 | 42.3 | 0.24 |
| With other survivors | 158 | 50.0 | Sex | Male | 80 | 46.2 | Female | 78 | 54.5 | 0.14 |
Outcomes | Overall | Demographic, medical and behavioural subgroup preferences
--- | --- | ---

### PA Prescription Preferences

| PA session frequency | Overall | Demographic, medical and behavioural subgroup preferences |
| --- | --- | --- |
| ≥ 3 days per week | 234 | 74.8 |
| n = 313 respondents | | |
| In relationship | No | 57 | 54.3 | Yes | 101 | 48.1 | 0.30 |
| On treatment | No | 89 | 46.4 | Yes | 69 | 55.6 | 0.11 |
| Physically active | No | 59 | 50.0 | Yes | 99 | 50.0 | 0.99 |

### PA session duration

| PA session duration | Overall | Demographic, medical and behavioural subgroup preferences |
| --- | --- | --- |
| ≥ 30 min per session | 225 | 77.6 |
| n = 290 respondents | | |
| In relationship | No | 79 | 79.0 | Yes | 145 | 76.7 | 0.66 |
| On treatment | No | 147 | 65.3 | Yes | 78 | 72.9 | 0.14 |
| Physically active | No | 65 | 61.9 | Yes | 160 | 86.5 | < 0.001 |

### PA training modality

| PA training modality | Overall | Demographic, medical and behavioural subgroup preferences |
| --- | --- | --- |
| Aerobic | 169 | 55.2 |
| n = 306 respondents | | |
| In relationship | No | 86 | 51.2 | Female | 83 | 60.1 | 0.12 |
| On treatment | No | 102 | 55.1 | Yes | 67 | 55.4 | 0.97 |
| Physically active | No | 58 | 50.4 | Yes | 111 | 58.1 | 0.19 |
| Boot camp | 113 | 37.0 |
| n = 305 respondents | | |
| In relationship | No | 41 | 39.8 | Yes | 72 | 35.8 | 0.50 |
| On treatment | No | 64 | 34.4 | Yes | 49 | 41.2 | 0.23 |
| Physically active | No | 42 | 36.5 | Yes | 71 | 37.4 | 0.88 |
| Circuit training | 146 | 48.2 |
| n = 303 respondents | | |
| In relationship | No | 48 | 46.6 | Yes | 97 | 48.7 | 0.72 |
| On treatment | No | 82 | 44.6 | Yes | 64 | 53.8 | 0.12 |
| Physically active | No | 38 | 33.3 | Yes | 108 | 57.1 | < 0.001 |
| Flexibility | 233 | 74.7 |
| n = 312 respondents | | |
| In relationship | No | 73 | 70.2 | Female | 114 | 81.4 | 0.01 |
| On treatment | No | 136 | 71.6 | Yes | 97 | 79.5 | 0.12 |
| Physically active | No | 83 | 71.6 | Yes | 150 | 76.5 | 0.33 |
| Strength | 256 | 82.6 |
| n = 310 respondents | | |
| In relationship | No | 157 | 83.1 | Yes | 99 | 81.8 | 0.78 |
| On treatment | No | 92 | 78.6 | Yes | 164 | 85.0 | 0.15 |
| Physically active | No | 92 | 78.6 | Yes | 164 | 85.0 | 0.15 |
| Walking | 246 | 78.3 |
| n = 314 respondents | | |
| In relationship | No | 123 | 70.7 | Female | 123 | 87.9 | < 0.001 |
| On treatment | No | 136 | 71.6 | Yes | 97 | 79.5 | 0.12 |
| Physically active | No | 93 | 68.7 | Yes | 143 | 73.0 | 0.003 |
| Yoga | 170 | 54.7 |
| n = 311 respondents | | |
| In relationship | No | 90 | 47.6 | Yes | 80 | 65.6 | 0.002 |
| Physically active | No | 59 | 50.9 | Yes | 111 | 56.9 | 0.30 |

**Notes:** n, number; Overall, overall participant preferences; PA, physical activity

*Italicized p values reflect those that remained significant following Benjamini and Hochberg correction with a calculated significance threshold set to:

A PA interest (p < 0.0167); b PA goals (N/A); c PA support start (p < 0.0071); d PA support setting (p < 0.0024); e PA support timing within week (p < 0.0063); f PA support timing within day (N/A); g PA supervision (p < 0.0024); h Sports (p < 0.0143); i Program restriction (p < 0.0125); j PA frequency (p < 0.0083); k PA modality (p < 0.0139)

Our study also has several limitations. First, ~ 60% of our sample consisted of respondents who identified as Caucasian and ~ 41% were testicular cancer survivors which may limit the generalizability of our findings to more ethnically and medically diverse individuals. Second, questionnaires had to be completed on-site during survivors’ medical appointments which may have discouraged the participation of AYAs who did not feel comfortable completing the questionnaire in front of the study staff, potentially leading to participation bias. Relatedly, our on-site recruitment approach resulted in a sample of AYAs who predominantly reside in large urban centres and whose PA support needs and interests may not reflect those living in smaller and more remote rural communities. Third, we included participants that met the common North American definition of an AYA (i.e. 18–39 years). Thus, our findings may not be completely generalizable to groups of AYAs defined by other age ranges (i.e. 15–24) [46]. Finally, the level of PA engagement across participants was extremely variable—possibly suggesting that the conditioning status of participants was similarly variable. While
conditioning status is difficult to accurately evaluate via self-report methods, it bears mention that the assessment and consideration of fitness levels are critically important to developing appropriately tailored exercise prescriptions for individuals, including AYAs [47].

Conclusion

In summary, most AYAs are active and interested in increasing their PA participation; yet, remarkably few engage with existing PA support services. AYAs’ PA preferences most often differ according to sex, treatment status, PA behaviour and preferred location of PA participation—and appear to be distinct from the preferences of older cancer survivors. Our findings highlight a potentially important discordance between the perceived and actual PA support preferences of AYAs that may partially explain their poor engagement with existing PA support services and the limited success of PA interventions in AYAs to date. Our findings, if generalizable, can be used to conduct the rigorous research needed to address the considerable gaps in the AYA-specific PA evidence base. Ultimately, these efforts will support the development of clinical- and community-based PA supportive care services to help reduce healthcare costs associated with treating and managing potentially preventable forms of chronic cancer-related sequelae within this rapidly growing survivor population.

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Data availability Study data is available upon request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval All procedures complied with the ethical standards of the local (University Health Network) and national (Canadian Institutes of Health Research) committees on human experimentation and the Helsinki Declaration.

Consent to participate Informed consent was obtained for all study participants prior to study inclusion.

Code availability NA

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