



Original Research

Heart Rate Response and Locomotor Activity of Female Skateboarders, BIPOC Skateboarders, and Non-skateboard Users During a Typical Session at a Community Skatepark

JEFF A. NESSLER[‡], ALIVIA L. LUNDQUIST^{*}, NATALIE CASAS JIMENEZ^{*}, and SEAN C. NEWCOMER[‡]

Department of Kinesiology, California State University-San Marcos, San Marcos, CA, USA

^{*}Denotes undergraduate student author, [‡]Denotes professional author

ABSTRACT

International Journal of Exercise Science 16(7): 599-612, 2023. Prior research has demonstrated that male adults and youth engaged in skateboarding at community skateparks achieve heart rates that meet or exceed recommendations for exercise by the CDC. However, these studies do not adequately evaluate other non-traditional or ethnically diverse users who may differ in how they utilize the skatepark and in their cardiovascular response. The purpose of this experiment was to measure heart rate response and locomotor movement in three *lesser studied* groups that frequently utilize community skateparks, and to compare these results with those reported previously in male adult and youth skateboarders. Fifty-six skatepark users were analyzed, including thirty female and BIPOC skateboarders, and twenty-six non-skateboard users. All participants were instrumented with a HR monitor with GPS capability and asked to engage in their preferred activity with no duration specified. Average heart rate and time spent at high and moderate levels of heart rate intensity were not statistically different among the groups studied here, nor were they different from those reported previously for male adult and youth skateboarders. Distances traveled, average, and peak velocities were also not statistically different among the groups studied here, but all were significantly lower than values previously reported for adult male skateboarders. While some differences in distances traveled and velocity were noted, all groups met or exceeded CDC guidelines for cardiovascular fitness. These data suggest that skateparks can help a community achieve health outcomes, particularly among diverse users.

KEY WORDS: Skateboarding, active travel, action sports, scooter, BMX, roller-skate

INTRODUCTION

Skateboarding is a popular sport with an estimated 12-20 million participants worldwide (3). Many participants choose to skateboard at a local facility or “skatepark” that was developed for recreational skateboarding and often includes terrain features such as bowls, ramps, rails, and ledges. Currently there are between 3200 and 4000 community skateparks in the U.S. and over 10,000 skateparks internationally (Concrete Disciples, (16)). Community skateparks provide a safe environment for individuals to participate in skateboarding, however many individuals

who utilize skateparks engage in other types of sport and physical activity, sometimes referred to as “active travel” (6). For example, many individuals use roller-skates, in-line skates, nonmotorized scooters, BMX (bicycle motocross), and wheelchairs at community skateparks (15, 36).

Despite its popularity and high participation rate, very little research has focused on skateboarding or other sports that can be performed at community skateparks. To date, much of the existing scientific literature focuses on skateboarding injury risk and its associated costs (25-27, 33, 36). Skateboarding is often considered to be more dangerous than other sports, but few studies have compared injury rates in skateboarding to those of other popular sports or modes of active travel (6, 13, 27). In addition, some studies have disputed the claim of higher injury rates among skateboarders (11) and suggest that skateboarding may have several important health benefits for youth, including psychological, emotional, and cardiovascular fitness (2, 11, 14, 17, 35, 39). In particular, recent studies suggest that skateboarding may provide an alternative mode of exercise for children who prefer to not participate in more popular team and structured sports such as soccer, baseball, or volleyball (14, 39). Further, some research suggests that engaging in these activities at a community skatepark rather than other urban settings may be associated with a reduced risk of injury (26). As interest in alternative sports such as skateboarding continues to grow, additional research on the risks, benefits, and characteristics of participation across diverse groups is needed.

Recreational skateboarding and other modes of active travel may have benefits for cardiovascular health and fitness. Recently, participation in skateboarding at community skateparks was shown to elicit heart rate responses associated with moderate to vigorous exercise (14, 39). Physical activity of this intensity and duration is associated with positive cardiovascular and weight management health outcomes (20, 22). Further, these data suggest that recreational participation in skateboarding meets the recommendations for daily physical activity from the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) (4, 21). However, since community skatepark users are diverse and their activities are unstructured, prior research on skateboarding may not be representative of all individuals who engage in these activities.

There are several factors that might influence physical activity and heart rate response of community skatepark users. For example, users of alternative modes of locomotion such as scooters or roller-skates, rather than skateboards, may focus on different features of the skatepark or exhibit different patterns of activity and rest. Prior research has indicated that participation in BMX, roller-skating, in-line skating, and non-motorized scootering can yield different heart rate responses (1, 7, 19, 24, 29, 34). Heart rate response and physical activity level can also vary across physiological variables. For example, cardiovascular adaptation to exercise has been shown to differ across athletes of different ethnic backgrounds, which includes ethnic differences in changes associated with hemodynamics, electrical conduction, and structure of the heart (8, 10, 30, 31). In addition, heart rate variability has been reported to differ across age and ethnicity (5, 12, 38). Further, a number of studies suggest that engagement in physical

activity in a community park setting varies across ethnicity, age, and sex (9, 18, 23, 32, 37). In particular, adults of different sex and ethnic backgrounds engage in moderate to vigorous intensity physical activity in a park setting at different rates and frequencies (18). These differences may be at least partially related to social interaction, which also plays an important role in community park visits and may be relevant to skatepark use (9, 37).

Taken together, these prior studies suggest that individuals of different ages, sex, ethnicity, as well as those who utilize different modes of locomotion, may exhibit different heart rate responses and levels of physical activity during recreational exercise. However, no data currently exist comparing these variables among the diverse groups of individuals who utilize community skateparks. Therefore, the purpose of this study was to measure heart rate response and gross locomotor activity in three minority groups that frequently utilize community skateparks: female skateboarders, BIPOC (Black, Indigenous, and People of Color) skateboarders, and non-skateboard users. A secondary purpose was to compare data from these three groups to data previously reported for male adult skateboarders and youth skateboarders. It was hypothesized that groups would differ in terms of locomotor activity, particularly non-skateboard users, but heart rate responses would be consistent across the groups studied here.

METHODS

Participants

Sixty-seven participants were recruited in-person at six different community skateparks in the San Diego County region. Individuals were invited to participate if they were engaged in skateboarding or another type of locomotion (BMX, scooter, roller-skates, etc) at a community skatepark, were between the ages of 7 and 55 years, had at least 6 months of experience at their preferred activity, and were female or BIPOC (for skateboarders only). Individuals who were both female and BIPOC were included in both groups for analysis. All individuals, regardless of sex, were recruited for both the BIPOC group and the alternative locomotion group. All participants provided their informed and written consent; parental consent and child assent were obtained prior to participation for individuals younger than 18 years. Participants also completed a questionnaire that included general information such as height, weight, and age, as well as typical skatepark usage and history. All experimental procedures were approved by the California State University, San Marcos Institutional Review Board (IRB#1812978-1), and this research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (28). *Data for eleven participants were excluded from the final analysis because there were significant gaps (greater than 10%) in heart rate data and/or the individual did not utilize the skatepark for at least 30 minutes.*

Protocol

All participants were instrumented with a Polar H7 heart rate transmitter at the chest and a V800 heart rate receiver on their wrist (Polar Electro, Inc., LakeSuccess, NY, USA). The H7 transmitter was placed below the pectoralis major, approximately at the level of the xyphoid process, and heart rate signal was verified prior to recording data. Researchers manually started and stopped

data collection on the V800 receiver at the start and end of the skate session. After instrumentation, participants were advised to engage in their normal level of activity within the boundaries of the skatepark. Session duration was determined by the participant. The transmitter and receiver recorded heart rate (bpm), duration (sec), speed (km · hr⁻¹), distance (km), and cumulative positive elevation change (m) at 1 Hz. Other session information, such as participant path, the type of skateboarding (e.g. street vs bowl), and interaction with particular features of the skatepark were not recorded. All data were uploaded from the V800 receiver to the Polar website via Polar FlowSync software, and all session information was downloaded as a comma separated variable (.csv) file to the researcher's computer. Custom routines written in Matlab (R2022b, Natick, MA) were used to analyze and aggregate data from all participants. These procedures were similar to those reported previously in youth and adult skateboarders (14, 39).

Statistical Analysis

Average heart rate, distance traveled, speed, and elevation change were calculated for the entire session for all three groups. Periods of rest (greater than 1 second) were determined from speed data (defined as speed less than 0.1 km · hr⁻¹) and were classified into one of four categories depending upon their duration: less than 10 seconds, 11-60 seconds, 1-3 minutes, greater than 3 minutes. Heart rates were then averaged within each period of rest, and an average HR was determined for each rest category. Participants were considered active when their speed was at least 0.1 km · hr⁻¹, and their average heart rate while active was calculated from these data. Heart rates were also normalized as a percentage of each participant's age predicted maximum heart rate (calculated as 220-age), and this was used to determine their exercise intensity at each time point (high ≥76%, moderate 64-75%, low 57-63%, and below low ≤ 57%). Time spent at each intensity level was expressed as a percentage of the total session duration for each participant and recorded for comparison.

Descriptive statistics were calculated and presented for each group studied here: female skateboarders, BIPOC skateboarders, and non-skateboarders. Data for female and BIPOC skateboarders were not compared statistically because some participants were included in both groups. However, comparisons were made between the non-skateboard group and both the female and BIPOC skateboard group using independent t-tests. In addition, the current data were compared with previously reported data in both adult (39) and youth (14) skateboarders using independent t-test. Variables compared included average HR across the entire session, total session duration, percent of time active, percent of time at rest, percent of time spent at each level of HR intensity, percent of time spent within each rest interval size, total distance traveled, average speed, peak speed, and elevation change. Effect size (Cohen's *d*) was calculated for each significant difference detected.

RESULTS

Session Information: Characteristics for individuals included in the final analysis are provided in Tables 1 and 2. Data from prior studies are also included in the table to facilitate comparison.

Individuals in the non-skateboard group utilized roller-skates (n=14, 54%), scooters (n=6, 23%), in-line skates (n=3, 12%), and BMX (n=3, 12%).

Table 1. Participant characteristics.

Current Study	N	Age [years]	Sex	Height [m]	Mass [kg]	Measured Session Duration [min]
All Participants	56	22.6±10.2	37F, 19M	1.62±0.1	59.0±14.9	54.2±19.1
Female Skateboarders	20	21.2±5.4	20F	1.61±0.1	53.7±9.6	50.6±12.1
Non-BIPOC Female	11	20±5.6	11F	1.62±0.1	51.4±8.2	48.3±13.3
BIPOC Skateboarders	19	28.6±10.7	9F, 10M	1.68±0.2	70.0±16.8	50.2±9.7
BIPOC Female	9	22.0±5.3	9F	1.59±0.2	56.5±11.0	53.3±10.4
BIPOC Male	10	34.5±11	10M	1.77±0.1	82.1±10.8	47.4±8.6
Non-Skateboard (NS) Users	26	19.7±10.0	17F, 9M	1.59±0.1	54.8±13.1	60.8±22.3
NS Female	17	20.4±10.9	17F	1.59±0.1	53.3±8.9	63.6±24.8
NS Male	9	18.3±8.7	9M	1.61±0.2	57.6±19.0	55.6±16.9
Prior Studies						
Adult Skateboarders*	45	27.4±8.5	44M, 1F	175.2±6.8	72.2±10.0	65.5±36.2
Youth Skateboarders**	71	10.4±2.7	63M, 8F	142.2±18.5	37.0±12.3	55.5±28.4

Data are expressed as mean ± SD; *Data taken from Wiles et al., 2020; **Data taken from Furr et al., 2018

Table 2. Participant experience.

Current Study	N	Self-Reported Experience [years]	Self-Reported Skateboarding Frequency [days week ⁻¹]	Self-Reported Session Duration [min]
All Participants	56	6.4±6.9	3.8±1.7	144.2±77.9
Female Skateboarders	20	4.3±4.9	4.4±1.8	163.3±69.2
Non-BIPOC Female	11	4.6±5.6	4.4±2.1	156±56.2
BIPOC Skateboarders	19	11.0±11.2	3.5±1.6	146.8±72.0
BIPOC Female	9	3.9±4.3	4.5±1.6	172.5±86.0
BIPOC Male	10	17.4±11.8	2.7±1.1	132±58.8
Non-Skateboard (NS) Users	26	4.6±5.2	3.6±1.8	127.2±87.0
NS Female	17	4.4±6.0	3.1±1.5	133±103.2
NS Male	9	4.8±3.5	4.5±1.9	118±56.4
Prior Studies				
Adult Skateboarders*	45	NA	3.5±2.0	134.8±76.5
Youth Skateboarders**	71	3.0±2.3	3.9±2.2	120.3±79.6

Data are expressed as mean ± SD; *Data taken from Wiles et al., 2020; **Data taken from Furr et al., 2018

Activity Levels: The average session duration for all participants was 53.0±19.9 minutes. Total session duration was significantly greater for non-skateboard users (60.8±22.3 min) when compared to BIPOC (50.2±9.7 min, $p=0.043$, Cohen's $d = 0.65$) skateboarders but not female skateboarders (50.6±12.1 min, $p=0.060$). Non-skateboarders also appeared to rest for a greater percentage of the session when compared to other skateboarding groups, and this difference

appeared to be attributable to an increase in rest periods that were greater than 3 minutes in duration (Figure 1).

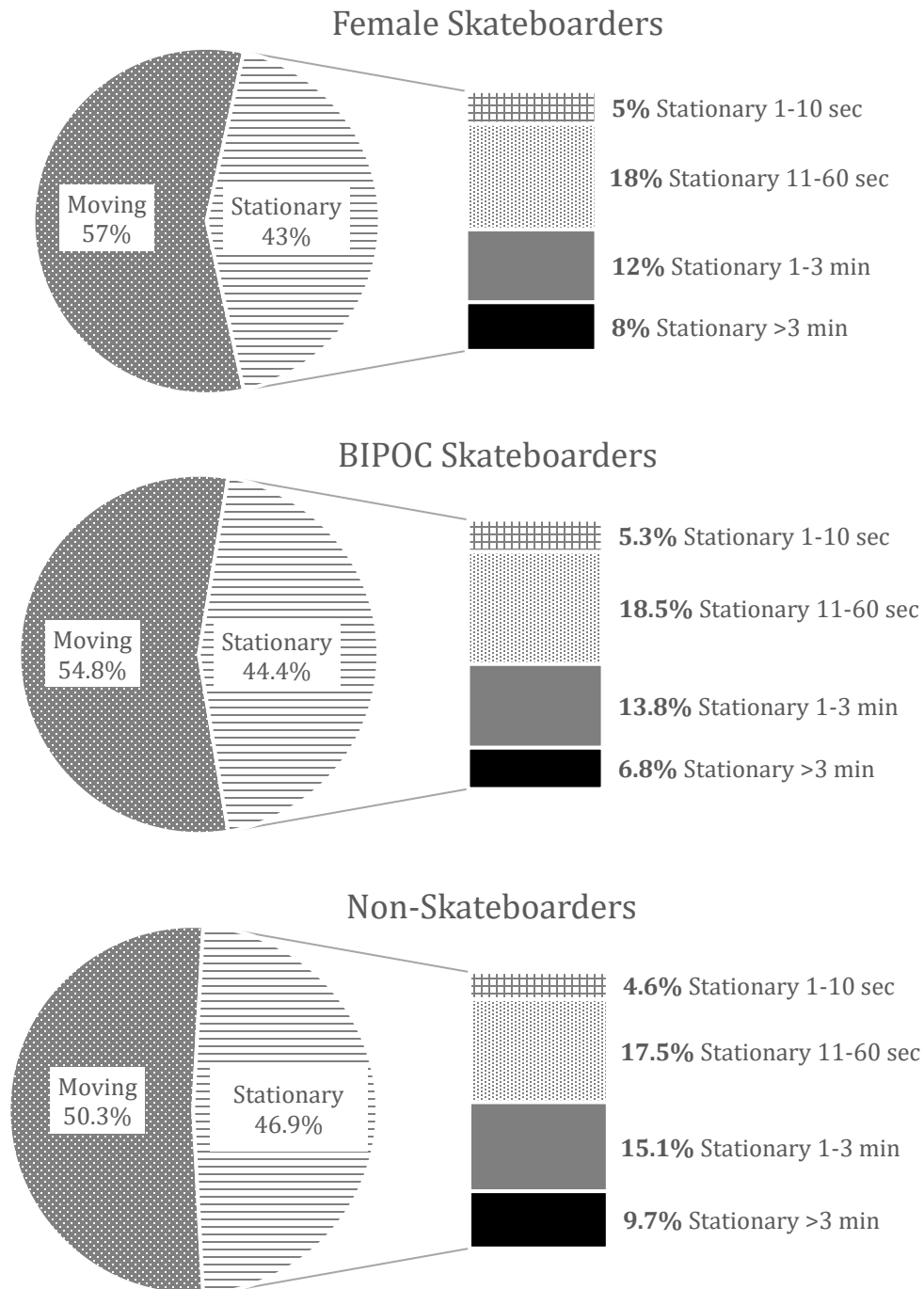


Figure 1. Percent of skateboard session spent moving vs at rest (stationary) for female skateboarders (n=20), BIPOC skateboarders (n=20), and non-skateboard users (n=27).

Heart Rate Response: No differences in heart rate variables were found between the non-skateboard and female or BIPOC skateboard groups studied here. However, female and BIPOC skateboarders exhibited significantly lower heart rates when at rest compared with previously reported data in youth skateboarders. Specifically, BIPOC skateboarders exhibited lower heart rates for rest durations of 1-10 seconds (103.6 ± 19.0 bpm vs 119.4 ± 19.1 bpm, $p < 0.001$, Cohen's $d = 0.87$) and 11-60 seconds (102.4 ± 18.7 vs 119.6 ± 19.4 bpm, $p < 0.001$, Cohen's $d = 0.83$, Figure 2). Since the BIPOC skateboard group was made up of both male and female participants, closer analysis revealed that these differences in heart rate at rest were primarily attributable to female BIPOC skateboarders ($n=10$) with mean heart rates of 98.4 ± 18.4 bpm for rest periods between 1-10 seconds and mean heart rates of 98.0 ± 18.0 bpm for rest periods between 11 and 60 seconds. For comparison, male BIPOC skateboarders ($n=10$) exhibited heart rates of 108.3 ± 19.2 bpm and 107.9 ± 18.9 bpm for the same rest intervals. Female skateboarders (all ethnicities) exhibited lower heart rates while at rest across all durations ($p < 0.05$, Cohen's $d = 0.67$ to 1.0) when compared to youth skateboarders. No differences were noted among any of the groups in the percent of the session spent at each level of heart rate intensity (Figure 3).

Locomotion: Speed and distances traveled were comparable among the female, BIPOC, and non-skateboard groups studied here (Figure 4). However, when compared with previously reported data in male adults, the female and non-skateboard groups studied here traveled significantly shorter distances ($p < 0.05$, Cohen's $d = 0.62$ and 0.69). Further, adult male skateboarders demonstrated a greater average speed for their sessions when compared with non-skateboarders studied here ($p = 0.001$, Cohen's $d = 0.87$, Figure 4).

Mean Heart Rates Moving vs Stationary

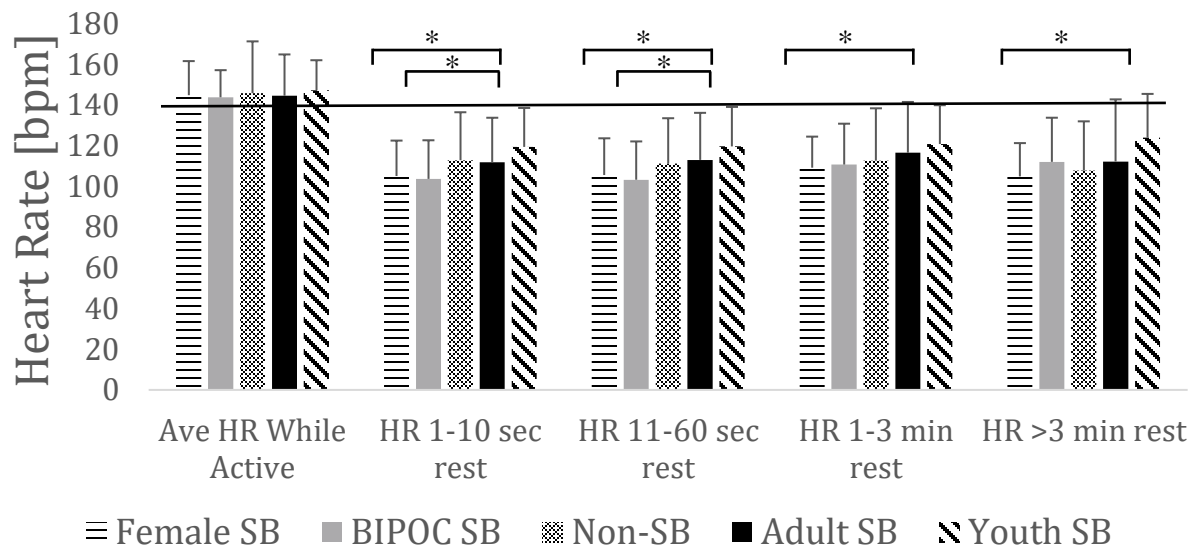


Figure 2. Average heart rates for different modes of activity and rest during a typical skatepark session for female skateboarders ($n=20$), BIPOC skateboarders ($n=19$), non-skateboard users ($n=27$), adult skateboarders ($n=45$), and youth skateboarders ($n=71$). Solid line represents average heart rate across all sessions. Asterisk (*) denotes significant difference ($p < 0.05$).

Percent of Session Spent at HR Intensity Levels

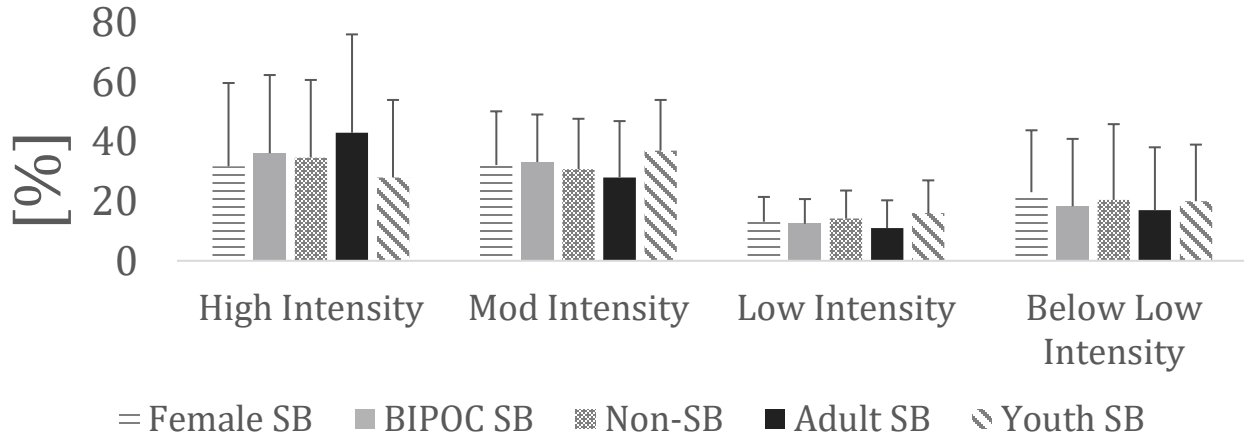


Figure 3. Average heart rates for different modes of activity and rest during a typical skatepark session for female skateboarders (n=20), BIPOC skateboarders (n=20), non-skateboard users (n=27), adult skateboarders (n=45), and youth skateboarders (n=71).

Session Average and Peak Speeds

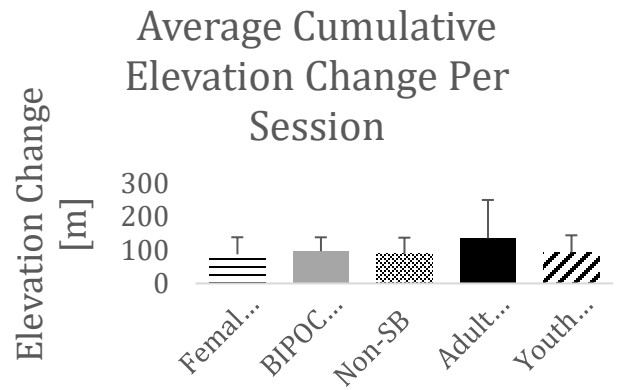
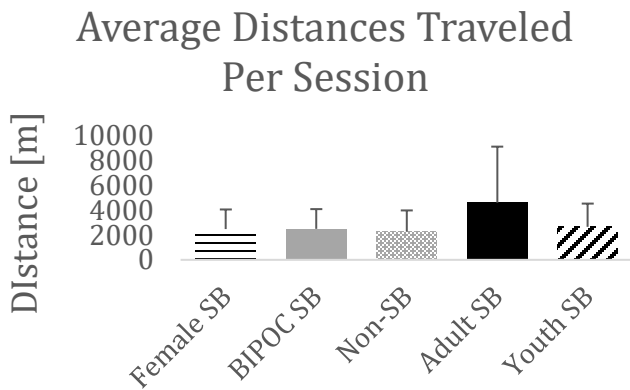
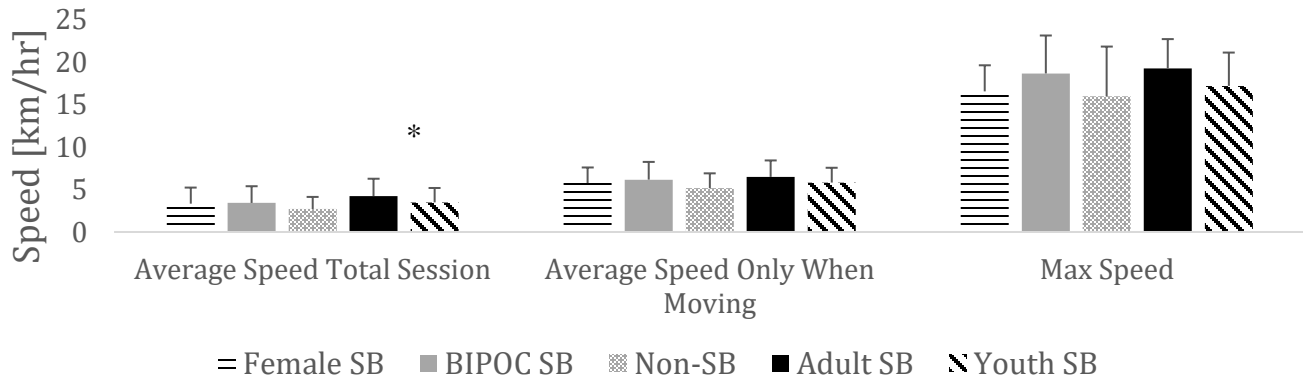


Figure 4. Average speed and distances traveled for individuals utilizing community skateparks. Female, BIPOC, and non-skateboard users were included in the current study, while adult and youth skateboarders were reported previously. Average elevation change represents the cumulative elevation change in the positive vertical direction across each session, averaged across participants. Asterisk (*) indicates significant difference ($p < 0.05$).

DISCUSSION

To date there has been limited research on the heart rate response to skateboarding and other sports that are performed at community skateparks, and additional data are needed to inform a broader analysis of the risks, benefits, and characteristics of participation across diverse skatepark users. The purpose of this study was to measure heart rate response and gross locomotor activity in three groups of individuals that frequently utilize community skateparks but have been underrepresented in prior studies: female skateboarders, BIPOC skateboarders, and non-skateboard users. In addition, these data were compared with previously reported data in predominantly male adult and youth skateboarders (14, 39). While some differences in raw heart rate were noted during periods of rest, when analyzed across the entire session the heart rate response was similar for all groups, suggesting that all groups engaged in moderate to vigorous physical activity for a similar duration. However, distances traveled, both vertical and horizontally, were significantly greater for the male adult skateboarders when compared with all other groups. In addition, adult male skateboarders exhibited significantly greater average speeds when compared with the non-skateboard group. No other differences in movement related data were noted. Taken together, these results suggest that differences in movement patterns exist across groups, but these differences did not translate to differences in heart rate response or exercise intensity. Therefore, participation in skateboarding and other modes of active travel can be an effective means for a wide variety of individuals to achieve the daily recommended level of exercise, despite potential variations in movement patterns.

Heart Rate Responses: Average heart rates were very similar across all participants studied here, and these data were comparable with previously reported data in male skateboarders aged 6-55 years (14, 39). For example, the average heart rate across the entire session ranged from a low of 138.4 ± 18.0 bpm for female skateboarders to a high of 140.4 ± 16.1 bpm for youth skateboarders. While prior research suggests that there may be differences in physiological response to exercise across ethnicity, age, and sex, the current data did not provide evidence of differences while engaged in recreational skateboarding (8, 10, 30, 31). Slight differences in average heart rate observed here may be accounted for by differences in heart rates during periods of rest, which were significantly lower in female and BIPOC skateboarders compared with previously reported heart rates in youth (14). However, when heart rates are adjusted for age, there are no differences in exercise intensity, as indicated by the percent of time spent at each level of age-adjusted HR intensity. Notably, female skateboarders spent $31.7 \pm 28.0\%$ of their session at high intensity and youth skateboarders spent $28.0 \pm 26\%$ of their session at high intensity (Figure 3). These data may have also been affected by the definition of rest used here (speed less than 0.1 m/sec), which may have allowed for some periods of rest that were not classified as such. For example, many skateboarders prefer to passively coast on their skateboards without active

propulsion in order to recover from periods of exertion. This would not have been considered a rest period under the analysis criteria used here.

The average duration of the skatepark session was 54.2 ± 19.1 min, which is less than the 60 minutes per day recommended for youth by the CDC and ACSM (4, 21). However, on average participants in the current study would be considered adult (mean age = 22.6 ± 10.2 years), and the CDC recommends 150 to 300 minutes of moderate to vigorous exercise per week for this age group. Based upon current self-reported data (Table 2), the average adult skateboarder or skatepark user exercises for over 500 minutes per week (144.2 minutes at 3.8 days per week). In addition, the recommended duration of exercise decreases with increasing exercise intensity (75 minutes per week of vigorous exercise for adults). Skateboarders in the current study spent between 28 and 43% of their session in the high intensity category, which likely meets the standard for vigorous exercise. Finally, it is also likely that the durations measured here were not indicative of the total amount of time an individual spent skateboarding in each day. Some participants may have decided to end data collection after 30 minutes but still planned to skateboard for additional time on the same day. This is supported by self-reported estimates of average session durations of at least 120 minutes (Table 2).

Prior research has indicated that there are differences in physical activity engagement and exercise at community parks across age, ethnicity, and sex (9, 18, 23, 32). The current data suggest that these differences may also apply to community skatepark use, based upon self-reported frequency and duration of skatepark use (Table 2). Specifically, BIPOC males reported visiting the skatepark for an average of 2.7 ± 1.1 sessions per week with an average session duration of 132 ± 58.8 minutes, while the average for the current data ($n=56$) was 3.8 ± 1.7 sessions per week and 144.2 ± 77.9 minutes per session.

Locomotor Activity: Adult, predominantly male and Caucasian skateboarders recorded the greatest distances traveled and greatest average speed per skate session (39). This could be due in part to experience and skill level, as older age groups are more likely to have additional years of experience. In addition, the average session for adult skateboarders was between 5 and 15 minutes longer than any other group (Table 1). No corrections were applied to the data to account for differences in skate session. It is also possible that the higher average speed for the adult skateboarders may have resulted from different patterns of use across the various terrains and features of the skatepark.

Non-skateboard users demonstrated the second longest average session duration. However, non-skateboard users exhibited lower distances traveled and lower average velocities when compared to other groups (Figure 4). The variation in type of activity or locomotion for this group may account for this result, as it was likely influenced by the high percentage of roller-skaters. In the current data, BMX and nonmotorized scooter riders exhibited higher average speeds (BMX: 6.07 ± 1.49 m/s, Scooter: 6.16 ± 0.61 m/s) when compared with that of roller-skaters (4.42 ± 1.88 m/s). Therefore, a greater percentage of BMX or nonmotorized scooter riders would

likely result in greater overall distances and speeds for this group. Future study should seek to examine each type of activity individually.

Limitations and Future Research: Prior studies of heart rate and distance traveled in skateboarders included relatively large sample sizes (14, 39). Each of the underrepresented groups examined here were small by comparison (n=19 and n=26). In addition, some individuals were included in both the BIPOC and female skateboard group (n=9), and this precluded statistical comparison between these two groups. Further, none of the groups could be considered homogeneous: the female skateboard group included both youth and adults, the BIPOC skateboard group included youth and adult as well as males and females, and the non-skateboard group included males, females, youth, adults, and various forms of alternative locomotion. In addition, the non-skateboard group included a high percentage of roller-skaters. These confounding variables should be considered when interpreting the current data.

Future research should focus on comparing groups in more detail by keeping ages and sexes consistent while comparing other variables. It is also recommended that skill and experience level be considered, as this may be a factor in distances traveled and average speed. While this study is the first to examine heart rate response in non-skateboarders using community skateparks, additional studies should focus on select subgroups within these individuals, including BMX, nonmotorized scooter, and in-line skating. Finally, future work should examine the relationship between use of specific features at the skatepark (e.g. bowl vs street) and heart rate response.

Conclusion: Data on the benefits of skateboarding and active travel are limited. This study sought to characterize the heart rate response and movement activity of three groups that utilize community skateparks but have been underrepresented in prior studies. Results indicated that there were some differences in distances traveled, average speed, and duration of the session among the groups observed, but heart rate responses were similar. These data suggest that all individuals can meet the CDC recommendations for exercise by participating in skateboarding or a similar sport at a community skatepark.

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