Physical activity engagement in Eldoret, Kenya, during COVID-19 pandemic

Karani Magutah1*, Grace Mbuthia2

1 Moi University School of Medicine, Eldoret, Kenya, 2 Jomo Kenyatta University College of Health Sciences, Juja, Kenya

* kmagutah@gmail.com, jkarani@cartafrica.org

Abstract

The World Health Organization (WHO) recommends that individuals of all ages participate in regular physical activity (PA) for optimal health and to support with the control of multiple non-communicable diseases. In Kenya however, involvement in PA across the general population is low and there is an increase in sedentary lifestyles in both rural and urban areas. An inverse relationship exists between socioeconomic status and involvement in PA. The novel COVID-19 ushered in associated control measures to limit the spread of the virus. These measures included staying at home, social distancing, and closure of physical spaces such as gyms, public parks, sports grounds, outdoor playing areas and schools. The impact was immediate, impacting patterns and routines of PA in Kenya. The primary aim of this study was to verify if COVID-19 affected PA prevalence and patterns amongst adults in Eldoret, Kenya. The secondary aim was to ascertain if the modification in behaviour is consistent amongst individuals from different socioeconomic backgrounds. We used a cross-sectional study to examine self-reported PA data amongst 404 participants. All participants were ≥18 years and resided in Eldoret, Kenya. Data were collected using a self-administered, structured questionnaire adapted from the WHO Global Physical Activity Questionnaire (WHO GPAQ). The characteristics of participants’ is summarized using descriptive statistics, and bivariate analyses for measures of associations of variables was done using Chi-squared and Fishers exact tests. Binary logistic regressions were performed to adjust for the various factors and report associations between variables. The \( p \)-value considered for significant differences was set at \(<0.05\). Participants in this study had mean age of 30.2 ±9.8 years. Almost 90% of the participants were not aware of the current WHO guidelines on PA, 9% stopped PA engagement after COVID-19 was first reported in Kenya, and only 25% continued regular PA. Less than half maintained PA intensity after the advent of COVID-19, with almost half reporting a drop. Males had a drop in time taken per PA session while females maintained session lengths after COVID-19 (\( p = 0.03\)). Males preferred gym-set or mixed-type PA while females opted for indoor (home) aerobics before and after COVID-19 (\( p = 0.01, p = 0.02 \) respectively). Compared to males, females were less likely to achieve both vigorous- and moderate-intensity PA recommendations (\( p<0.01 \) and \( p = 0.02 \) respectively). Zone of residence was associated with participation in aerobic PA (\( p = 0.04; 95\% \text{ CI} = 0.02499–0.96086 \)) and, similarly, level of education was associated with knowledge of WHO recommendations for PA (\( p = 0.01; 95\% \text{ CI} = -1.7544 - -0.2070 \)). A majority of...
the urban population of Eldoret, Kenya and especially those with lower level of education are unaware of WHO recommendations for PA, and 30% of them have not engaged in any form of PA for many years. The majority that report involvement in PA do not achieve the WHO recommended threshold levels of PA. The results also indicated that COVID-19 has negatively affected intensity of PA, and that there has been an increase in time spent sitting/reclining amongst individuals in the higher socio-economic classes and specifically amongst females.

Introduction

The World Health Organization (WHO) recommends regular physical activity (PA) across all age groups to prevent and manage non-communicable diseases and promote optimal health and wellness [1]. Physical activity data are plentiful and a positive curvilinear relationship between involvement in PAs of various intensities and fitness has long been established [2]. Physical activity largely contributes to a reduction in premature mortality by controlling cardiovascular disease, various cancers, diabetes and also by promoting mental health [2, 3]. This in turn translates to better overall health for individuals. It is this knowledge that has informed the existing guidelines and recommendations and also the current pool of evidence suggesting that even different exercise regimes as one form of PA would achieve similar health benefits. According to the WHO, 150 minutes of moderate-intensity PA done weekly yields the same health benefit as 75 minutes of vigorous-intensity PA. Our recent studies found that bouts of moderate-intensity PAs that are as short as 7.5 minutes, if performed thrice daily so that their cumulative time equals the WHO recommendation, yields similar health benefits, presenting additional options of regimens of PA to choose from [1, 4, 5].

Despite these WHO recommendations or other proposed options, PA involvement in Kenya remains generally low. Sedentary lifestyles are on the rise, and high inactivity levels can be found in both rural and urban areas [6–9]. Sedentary lifestyle and physical inactivity is the fourth leading risk factor for mortality globally [1] and this is worrying because in Eldoret, Kenya, 82% of elderly inhabitants do not participate in any known form of PA [10]. The start of the novel COVID-19 pandemic immediately led to control measures that entailed individuals having to social distance and stay at home. Due to the pre-existing low involvement levels of participation in outdoor PA, there was concern that the levels of PA would decline further [10]. There have been extensive debates and discussions on how to improve outdoor PA in the past, and there was now concern that even indoor home-based PAs may also be negatively impacted [1, 4, 5, 10–12]. While PA continued to be recommended during confinement associated with COVID-19 [13], the emerging data on how COVID-19 is affecting PA suggests that individuals are further reducing their participation in PA [14]. This is despite temporary recommendations suggesting home-based PAs during the COVID-19 confinement [15]. This drop has specifically been observed in older age groups and in individuals with non-communicable diseases such as diabetes [16, 17], and comes at a time when a rise in sedentary lifestyles and inactivity are associated with the increase in non-communicable diseases in Kenya and globally [6–9, 18–21]. We currently however do not have data on the effect of COVID-19 on PA in Kenya or from the eastern African region, and therefore with the absence of data are unable to paint an accurate picture of how Kenya compares globally in relation to PA changes during the pandemic.
Participation in PA has been low across all ages and populations locally and globally and while the quest to overcome this problem is unresolved [1, 4, 5, 10–12], there is a major concern that COVID-19 may reverse overall population fitness gains in general [22, 23]. Lower education and income levels have already been shown to be associated with lower involvement in PA in both males and females of all ages, and that an inverse relationship exists between social economic status and sedentary time, compounding the concern in our set up. Individuals in the lower socio economic strata have more sitting and screen-time compared to those of the higher socio economic statuses [24–28]. Local data is minimal however, and this paucity of data from lower socio-economic countries contribute the current recommendation of need for more work to adequately demonstrate how socioeconomic status impacts PA involvement [29].

Recently, new data showed that PA regimens involving shorter periods of activity that are repeated several times a day led to improved PA adherence in individuals from all socio-economic statuses [4, 5, 30–33]. However, the start of COVID-19 mitigation measures such as physical isolation have introduced further barriers to participation in PA.

We are aware that stay-at-home-orders may negatively affect PA involvement, but we are unsure exactly how this has impacted our population’s participation in PA. Recent emerging studies have documented a decline in metabolic equivalent minutes of PA in United States of America and the United Kingdom [34–36]. Given the many adjustments in behavioural aspects of life during the pandemic, we envisage a similar drop in PA participation in Kenya. Currently, the Kenyan Ministry of Health (MOH) has instructed individuals over 58 years and those with underlying health conditions to work from home and to limit outdoor engagements. Earlier, the MOH had recommended a lockdown that entailed stay-at-home for most of the population [37].

In order to develop responsive health policies, it is important to conduct research to obtain data on the current PA participation rates one year since the first case of COVID-19 was identified in Kenya. A comprehensive set of data will explain how working / staying at home and limiting outdoor engagements have affected the general population and their participation in PA, and how this may affect lifestyle diseases for the population in the future. It is hoped that this study will provide timely evidence-based data that will facilitate interventions to mitigate a potential increase in non-communicable lifestyle diseases due to the COVID-19 measures aimed to mitigate the spread of the virus [22, 23, 34–36]. The results of this study will directly contribute to the global enquiry to develop common recommendations for PA during the pandemic that can be implemented as policy by the various stakeholders [38]. The primary aim of this study is to verify if COVID-19 has affected PA prevalence and patterns amongst adults in Eldoret, Kenya. The secondary aim is to verify if the modifications to PA is the same for the different sexes and if the modifications differ depending on individuals’ socio-economic backgrounds.

Methods

Ethics statement

Ethical approval was granted by Moi Teaching and Referral Hospital / Moi University research ethics committee (MTRH/MU IREC), approval no. 0003800. All participants provided written informed consent for participation. Participants were assured of confidentiality and anonymity, and no identifiers were used throughout the study.

Design

This was a cross-sectional study.
Study population and site
Participants were adults (aged ≥18 years) residing in Eldoret town and its peri-urban area within a 10 kilometers radius from the central business district (CBD).

Sample size
The prevalence of PA participation in Eldoret is 18% [39]. This study is not only too old but was also conducted before the COVID-19 pandemic. Thus, we assumed PA involvement prevalence of 0.5, a 5% level of precision, and a Z value of 1.96 corresponding to 95% CI, yielding a sample size of 384 participants.

Sampling procedure
Participants’ selection first entailed a random selection of the estates from where a systematic criterion was employed. For participating estates, we listed estates of Eldoret town that are within a radius of ten kilometers. From these estates, we used anecdotal allocation into 2 groups for the affluent and the less affluent estates based on the availability of basic infrastructure, housing cost and affordability. An individual’s income places them into certain socioeconomic status largely collapsed into higher or lower economic status, and choice of residence is associated with this. Each of the two groups contributed half of the sample. A computerized random selection of four (4) estates from each category was done. We selected participants using systematic sampling based on information on the estimated number of total homes/households in the estate obtained from the village/estate elders. We determined sampling interval by first allocating the sample of 384 into the two categories equally. Thereafter, proportionate allocation based on total household numbers per estate was done, which determined the sampling interval for each of the estates by dividing the households number by the allocated sample for that estate. From the selected households, we sampled the first respondent that we encountered and although we had a replacement criterion if there was an ineligible household where respondents were below 18 years old, this never became necessary. This is summarized in Fig 1.

Eligibility
The inclusion criteria was male and female individuals aged ≥18 years regardless of their current or previous PA history, residing within a 10-kilometer radius from Eldoret CBD, and without medical advice to keep off PAs.

Data collection
Four trained research assistants collected data from 15th March to 14th April 2021 in private rooms or outdoors at participants’ homes. The collected data included bio-demographic characteristics and self-reported information regarding PA. Data were collected using a structured questionnaire adapted from the WHO Global Physical Activity Questionnaire (WHO GPAQ). The tool included any activity that raised heart rate during performance as classified using the WHO GPAQ generic showcards that were attached to it. Thus, PA was categorized into mild, moderate or vigorous-intensity. Participants also gave an estimate of the time they spent on each activity which yielded a cumulative weekly minutes of PA. The tool was designed to either be self-administered by participants who could read and write or to be interviewer-administered for illiterate participants.
Stata version 13 (College Station, TX: StataCorp LP) was used for data entry and analysis. Univariate and bivariate analyses were performed. Continuous data such as age were summarized

**Table 1. Demographic characteristics.**

| Variable                      | Zone 0 (Lower income) Mean ± SD or n (%) | Zone 1 (Higher income) Mean ± SD or n (%) | Overall Mean ± SD or n (%) |
|-------------------------------|------------------------------------------|-------------------------------------------|----------------------------|
| Mean age (N = 404)            | 30.6±10.3 (n = 202)                      | 29.9±9.3 (n = 202)                        | 30.2±9.8 (n = 404)         |
|                               | [Males 29.0±8.5 (n = 94); Females 31.9±11.6 (n = 108)] | [Males 28.8±8.2 (n = 96); Females 30.8±10.2 (n = 106)] |                             |
| Education level (N = 400)     |                                          |                                           |                            |
| None                          | 4 (2)                                    | 2 (1)                                     | 6 (1.5)                    |
| Primary                       | 50 (25)                                  | 13 (6.5)                                  | 63 (15.75)                 |
| Secondary                     | 85 (42.5)                                | 58 (29)                                   | 143 (35.75)                |
| Tertiary                      | 61 (30.5)                                | 127 (63.5)                                | 188 (47)                   |
| Employment (N = 402)          |                                          |                                           |                            |
| None                          | 77 (38.3)                                | 83 (41.3)                                 | 160 (39.8)                 |
| Self Employed                 | 87 (43.3)                                | 63 (31.3)                                 | 150 (37.3)                 |
| Formally Employed             | 37 (18.4)                                | 55 (27.4)                                 | 92 (22.9)                  |
| Work entails physical exertion (N = 402) |                                          |                                           |                            |
| Yes                           | 77 (38.7)                                | 48 (24.9)                                 | 125 (31.9)                 |
| No                            | 122 (61.3)                               | 145 (75.1)                                | 267 (68.1)                 |

---

**Data management and analysis**

Stata version 13 (College Station, TX: StataCorp LP) was used for data entry and analysis. Univariate and bivariate analyses were performed. Continuous data such as age were summarized...
using means and their standard deviations while categorical data such as PA time-length were summarized using frequencies and percentages to depict participants’ characteristics based on their zones of residence described above. Bivariate analyses were based on the various PA-related variables studied per sex groups and age categorizations. These bivariate analyses for measures of associations were done using Chi-squared tests. Odds ratios and 95% confidence intervals were reported when associations were significant for binary outcomes associated with PA. To report associated factors and adjust for the various confounders, logistic regressions at 95% confidence interval were performed for effect of various independent variables on select binary outcomes. \( P \) values of <0.05 were considered statistically significant.

**Results**

The mean age of the participants was 30.2±9.8 years (males 28.9±8.3 (n = 190); females 31.4 ±10.9 (n = 214)). One in every four participants had a minimum of secondary level of education and the majority were in the working class. The demographic characteristics are shown in Table 1.

**Physical activity awareness and patterns**

Almost 9 in 10 participants were unaware of the current WHO guidelines on PA and the majority (52.9%) of these respondents came from the lower-income zones. Nine percent of the participants reported that they had stopped exercising after COVID-19 was first reported in Kenya, and most of these individuals lived in lower-economic zones/estates. Based on reported session duration and number of days of PA per week, only 25% of participants achieved the recommended threshold of weekly minutes of PAs, a majority of whom came from the lower-economic estates. Physical activity awareness and reported PA history are shown in Table 2 while patterns of PA are shown in Table 3.

Bivariate analyses showed that while individuals from lower-income estates were more likely to participate alone in PA (\( p = 0.01 \)), in organized gym sessions (\( p = <0.001 \)) and preferred outdoor running (\( p = 0.02 \)), those from higher-income estates did PA either alone or with others, preferred indoor PA at home or in the gym, and performed a mixture of PAs which included park/estate running both before and after COVID-19. Those from high socio-economic estates preferred gym aerobics and indoors/home aerobics while those from lower socio-economic estates preferred walking. Before COVID-19, the lower socio-economic estate individuals preferred doing morning PAs as opposed to the evening as preferred by the higher socio-economic estates’ participants. Table 4 summarizes variables with significant differences between zones.

Males were twice more likely to be aware of the WHO recommendations for PA compared to females (OR = 2.09 (95% CI 1.05–4.30); \( p = 0.02 \)). Females tended to participate in PA alone or in combination with a family member whereas males preferred to exercise in groups or at the gym (\( p = <0.001 \)). Females also preferred mild-to-moderate intensity PAs while males preferred vigorous-intensity (\( P = <0.001 \)). The odds of achieving the recommendations for vigorous-intensity PA were 5.21 (95% CI 2.35–12.7) times higher in males than females. The odds of achieving moderate-intensity PA recommendations were also higher in males than females (OR 1.6 (95% CI 1.06–2.46). Before COVID-19, males had longer sessions of PA (\( p = 0.01 \)) and this sex difference was lost after COVID-19. Males had a drop in time taken per PA session while females maintained session lengths after COVID-19 (\( p = 0.03 \)). Males also preferred gym-setup or mixed-type PAs while females opted for indoor (home) aerobics before and after COVID-19 (\( p = 0.01 \), and \( p = 0.02 \) respectively). Further, both before and after COVID-19, males preferred running and ball game PAs as opposed to walking and indoor aerobics for
females (p<0.001 for both). Males also preferred planned (morning or evening) PAs while females participated in PA only as time became available both before and after COVID-19 (p = 0.02 and p = 0.03 respectively). Table 5 summarizes associations of sex and the various variables, with odds ratios provided for binary outcomes.

To determine the associated factors and degree of such associations, a binary logistic regression model to predict factors that affected current participation in aerobic PA while controlling for other confounders showed that only zone of residence had statistically significant association (p = 0.04; 95% CI = 0.02499–0.96086) where individuals from lower socio-economic zones had higher participation. Age, sex, knowledge of WHO recommendation for PA and level education all were not significantly associated with participation in PA. Similarly for knowledge of WHO recommendations for PA, only level of education was associated (p = 0.01; 95% CI = -1.7544 - -0.2070) such that individuals with higher education levels were more likely to be aware of existing recommendations compared to those with lower education. Variables such as zone of residence, age, and sex were not associated with knowledge of WHO recommendations for PA (all p>0.05).

**Discussion**

To the best of our knowledge, this is the first study to report on how COVID-19 has affected PA amongst individuals in Kenya. The current study found that 9 in 10 participants were unaware of the current WHO guidelines that recommend 150 or 75 weekly minutes of moderate- or vigorous-intensity PA, respectively [1]. Bio-demographic characteristics of age and sex had no statistical association with this knowledge and only level of education was statistically associated where individuals with higher education were more likely to be aware of existing
Table 3. Patterns of pas.

| Variable | Zone 0 (Lower income) n (%) | Zone 1 (Higher income) n (%) | Overall n (%) |
|----------|-----------------------------|-----------------------------|--------------|
| PA intensity (N = 272) |                     |                             |              |
| Mild     | 44 (30.3)                   | 40 (31.5)                   | 84 (30.9)    |
| Moderate | 89 (61.4)                   | 70 (55.1)                   | 159 (58.5)   |
| Vigorous | 12 (8.3)                    | 17 (13.4)                   | 29 (10.7)    |
| PA intensity change since COVID-19 (N = 272) |                     |                             |              |
| Maintained intensity | 57 (39.3)                   | 58 (45.7)                   | 115 (42.3)   |
| Dropped intensity | 65 (44.8)                   | 46 (36.2)                   | 111 (40.8)   |
| Increased intensity | 23 (15.9)                   | 23 (18.1)                   | 46 (16.9)    |
| Mod. intensity attainment of 150 mins (N = 268) |                     |                             |              |
| Yes      | 90 (62.1)                   | 90 (73.2)                   | 180 (67.2)   |
| No       | 55 (37.9)                   | 33 (26.8)                   | 88 (32.8)    |
| Vig. intensity attainment of 75 mins (N = 265) |                     |                             |              |
| Yes      | 15 (10.4)                   | 24 (19.8)                   | 39 (14.7)    |
| No       | 129 (89.6)                  | 97 (80.2)                   | 226 (85.3)   |
| Weekly days of PA (N = 270) |                     |                             |              |
| Daily    | 41 (28.3)                   | 22 (17.6)                   | 63 (23.3)    |
| ≥4       | 49 (33.8)                   | 52 (41.6)                   | 101 (37.4)   |
| ≤3       | 33 (22.8)                   | 33 (26.4)                   | 66 (24.4)    |
| Rarely   | 22 (15.2)                   | 18 (14.4)                   | 40 (14.8)    |
| Weekly days of PA pre-COVID-19 (N = 272) |                     |                             |              |
| Daily    | 43 (29.6)                   | 28 (22.1)                   | 71 (26.1)    |
| ≥4       | 50 (34.5)                   | 55 (43.3)                   | 105 (38.6)   |
| ≤3       | 22 (15.2)                   | 23 (18.1)                   | 45 (16.5)    |
| Rarely   | 30 (20.7)                   | 21 (16.5)                   | 51 (18.8)    |
| Bout lengths (today) (N = 267) |                     |                             |              |
| <10 mins | 14 (9.9)                    | 13 (10.4)                   | 27 (10.1)    |
| ≥10 - <30 mins | 47 (33.1)                   | 43 (34.4)                   | 90 (33.7)    |
| ≥30 mins | 81 (57.0)                   | 69 (55.2)                   | 150 (56.2)   |
| Bout lengths (pre-COVID-19) (N = 265) |                     |                             |              |
| <10 mins | 22 (15.7)                   | 15 (12)                     | 37 (14.0)    |
| ≥10 - <30 mins | 35 (25)                    | 40 (32)                     | 75 (28.3)    |
| ≥30 mins | 83 (59.3)                   | 70 (56)                     | 153 (57.7)   |
| PA length change since COVID-19 (N = 265) |                     |                             |              |
| Maintained bout length | 27 (19.3)                   | 21 (16.8)                   | 48 (18.1)    |
| Dropped bout length | 43 (30.7)                   | 41 (32.8)                   | 84 (31.7)    |
| Increased bout length | 70 (50)                     | 63 (50.4)                   | 133 (50.2)   |
| Pre COVID-19 place of PA (N = 269) |                     |                             |              |
| Gym      | 8 (5.6)                     | 16 (12.7)                   | 24 (8.9)     |
| Home (indoors) | 23 (16.1)                   | 21 (16.7)                   | 44 (16.4)    |
| Outdoors (park / estate | 100 (69.9)                   | 66 (52.4)                   | 166 (61.7)   |

(Continued)
Table 3. (Continued)

| Variable | Zone 0 (Lower income) n (%) | Zone 1 (Higher income) n (%) | Overall n (%) |
|----------|-----------------------------|-----------------------------|---------------|
| Mixed (≥2 above) | 8 (5.6) | 19 (15.1) | 27 (10.0) |
| Others | 4 (2.8) | 4 (3.2) | 8 (3.0) |
| Current place of PA (N = 269) | | | |
| Gym | 4 (2.8) | 10 (8.0) | 14 (5.2) |
| Home (indoors) | 28 (19.4) | 38 (30.4) | 66 (24.5) |
| Outdoors (park / estate) | 99 (68.8) | 63 (50.4) | 162 (60.2) |
| Mixed (≥2 above) | 8 (5.6) | 12 (9.6) | 20 (7.4) |
| Others | 5 (3.5) | 2 (1.6) | 7 (2.6) |
| Pre COVID-19 PA types (N = 267) | | | |
| Running | 44 (31.2) | 44 (34.9) | 88 (33.0) |
| Walking | 60 (42.6) | 35 (27.8) | 95 (35.6) |
| Aerobics (all types) | 29 (20.6) | 38 (30.2) | 67 (25.1) |
| Ball games | 8 (5.7) | 9 (7.1) | 17 (6.4) |
| Current PA types (N = 265) | | | |
| Running | 43 (30.5) | 40 (32.2) | 83 (31.3) |
| Walking | 62 (44.0) | 31 (25.0) | 93 (35.1) |
| Aerobics (all types) | 27 (19.1) | 42 (33.9) | 69 (26.0) |
| Ball games | 9 (6.4) | 11 (8.9) | 20 (7.6) |
| Work-out day of the week now (N = 264) | | | |
| Any day of week | 104 (75.3) | 95 (75.4) | 199 (75.4) |
| Only weekends/holidays | 19 (13.8) | 17 (13.5) | 36 (13.6) |
| Only weekdays | 15 (10.9) | 14 (11.1) | 29 (11.0) |
| Work-out day of the week pre-COVID-19 (N = 264) | | | |
| Any day of week | 110 (79.1) | 96 (76.8) | 206 (78.0) |
| Only weekends/holidays | 17 (12.2) | 13 (10.4) | 30 (11.4) |
| Only weekdays | 12 (8.6) | 16 (12.8) | 28 (10.6) |
| Preferred PA time now (N = 260) | | | |
| Any time available (doesn’t matter) | 66 (48.5) | 50 (40.3) | 116 (44.6) |
| Morning between 6 and 8 am | 37 (27.2) | 27 (21.8) | 64 (24.6) |
| Evening between 5 and 7 pm | 29 (21.3) | 42 (33.9) | 71 (27.3) |
| Night (between 7pm and 6am) | 4 (2.9) | 5 (4.0) | 9 (3.5) |
| Preferred PA time pre-COVID-19 (N = 259) | | | |
| Any time available (doesn’t matter) | 68 (50.4) | 55 (44.4) | 123 (47.5) |
| Morning between 6 and 8 am | 35 (25.9) | 19 (15.3) | 54 (20.9) |
| Evening between 5 and 7 pm | 28 (20.7) | 44 (35.5) | 72 (27.8) |
| Night (between 7pm and 6am) | 4 (3.0) | 6 (4.8) | 10 (3.8) |

(Continued)
recommendations for PA. Except for level of knowledge where the current study shows an association, our findings replicate what has already been shown elsewhere [40]. Our study was carried out in a region of Kenya renown for producing world-class athletes and this could probably explain why individuals with higher level of education may be aware of the recommendation for PA as they probably read about and follow on performance of such elite athletes, a feat individuals with less education may not study through or relate.

One in three participants had not engaged in any PA for years, which mirrors WHO reports that 25–33% of individuals worldwide do not engage in PAs at all [41]. A total of 68% of participants considered themselves aerobically active, however only 30% of these individuals actually achieved the recommended threshold of weekly minutes of PA. This translated to an overall of 25% prevalence in attainment of PA recommendations. Amongst the PA achievers, the majority came from the lower-economic estates, tended to be males, and were performing moderate-intensity PAs. Zone of residence was statistically associated with participation in PA where individuals from lower-economic zones were more likely to be involved when compared to those from the higher-economic zones. The findings are consistent with data showing that lower, rather than higher income, is positively associated with higher PA involvement [41]. While our current work only examined individuals from one town in Kenya with differing socio-economic status, the findings do however mirror other studies comparing higher- and lower-income countries which show that lower-income individuals tend to be more active than their higher income counterparts [41]. There is however an ongoing debate in the literature with dissenting studies refuting this association [42].

While it has been shown that it is still possible for some to attain PA recommendations during the COVID-19 pandemic [43], 9% of participants in our current study stopped exercising after COVID-19 was first reported in Kenya, and the majority of these participants came from lower economic zones/estates. Less than half of the participants maintained previous PA intensity after the advent of COVID-19, with almost half reporting a drop in activity. It should be noted that there was no change in preferred day-of-the-week for PA, PA type, session length

Table 3. (Continued)

| Variable                                      | Zone 0 (Lower income) n (%) | Zone 1 (Higher income) n (%) | Overall n (%) |
|-----------------------------------------------|-----------------------------|------------------------------|---------------|
| Mean minutes spent sitting/reclining (N = 369) | 258.5±175.8 range (19.8–900). Males (n = 84) 289.3±199.8 Range (30–900) Females (n = 102) 233.1±149.6 range (19.8–720) | 311.3±194.4 range (30–1020). Males (n = 89) 355.6±189.1 Range (30–1020) Females (n = 94) 288.4±197.6 range (30–840) | 284.7±186.9 range (19.8–1020). Males; n = 173 313.1±195.2 range (30–1020) Females; n = 196 259.6±176.0 range (19.8–840) |
| Time spent sitting/reclining since COVID-19; N = 393 |                             |                              |               |
| Increased                                     | 115 (58.7)                  | 105 (53.3)                   | 220 (56.0)    |
| Maintained                                    | 67 (34.2)                   | 75 (38.1)                    | 142 (36.1)    |
| Reduced                                       | 14 (7.1)                    | 17 (8.6)                     | 31 (7.9)      |

https://doi.org/10.1371/journal.pgh.0000339.t003

Table 4. Association between zone (reference, low socioeconomic) of residence and various variables.

| Variable                                      | Pearson χ² | P value |
|-----------------------------------------------|------------|---------|
| Participation in hard physical labour         | 8.62       | <0.001  |
| Normalcy of exercise (alone, group, combinations) | 14.2    | 0.01    |
| Preferred exercises location (gym/home/park/estate/mix) before COVID | 20.6 | <0.001 |
| Preferred exercises location (gym/home/park/estate/mix) currently | 16.6 | <0.001 |
| Preferred exercises (running/ball games/walking/gymnastics) currently | 9.57 | 0.02    |
| Preferred time-of-day for a workout before COVID (morning) | 8.58 | 0.04    |

https://doi.org/10.1371/journal.pgh.0000339.t004
or place of PA for those who maintained their activity levels during the pandemic. The time spent sitting increased for the majority of the participants, with only one-third maintaining pre-COVID-19 sitting time and only 8% of participants reducing their sitting time, echoing studies elsewhere [44, 45]. Reviews of recent studies have highlighted that COVID-19 may have negatively impacted PA involvement as per the results of our study [46, 47]. Our study further added that the higher socio-economic strata was more adversely affected during COVID-19 as it pertain to PA levels, although there was an overall drop in PA levels across both higher and lower socioeconomic classes. Only 25% of participants, who mostly hailed from lower economic estates, reported exercising regularly. These individuals from the lower-socioeconomic estates who participated in PA reported doing PA while alone, in organized outdoor-exercises (park or estate), and preferred to do walks. This differed from those from higher socio-economic status who preferred various combinations for whom to exercise with, and who, further, preferred PAs done indoors either at home or at a gym (or mix), and preferred aerobic activities both before and after COVID-19. It appears COVID-19 did not change preferences of where to do PA or with whom for all participants. The start of the novel COVID-19 did however affect the preferred time of day for PA. Before COVID-19, participants from higher socio-economic estates preferred evening PAs and those in the lower socio-economic estates tending to morning hours. However, after COVID-19, this association was lost. This could be associated with COVID-19 mitigation measures that have reduced opportunities for PAs due to the suspension of outdoor engagement prospects. We still however have insufficient data to fully demonstrate the entire impact of the pandemic on PA [44, 47–49].

Females were twice less likely than males to be aware of the WHO recommendations for PA, and, were more likely to participate alone in PA or in combination with a family member

| Table 5. Association between sex (reference, males) and various variables. |
|-------------------------------------------------|
| Knowledge of WHO exercise recommendation | 5.15 | 0.02 | 2.09 (1.05–4.30) |
| Participation in hard physical labour | 0.33 | 0.57 |
| Whether currently active in aerobic exercises | 0.06 | 0.80 |
| Normalcy of exercise (alone, group, combinations) | 15.7 | <0.001 |
| Current exercise intensity | 22.5 | <0.001 |
| Whether exercise intensity changed since COVID-19 | 5.08 | 0.08 |
| Whether meeting 150 minutes moderate intensity exercise | 5.64 | 0.02 | 1.61 (1.06–2.46) |
| Whether meeting 75 minutes vigorous intensity exercise | 21.2 | <0.001 | 5.21 (2.35–12.7) |
| Regularity of aerobic exercises (current) | 0.60 | 0.90 |
| Regularity of aerobic exercises (before COVID-19) | 2.0 | 0.57 |
| Exercise session length | 9.12 | 0.01 |
| Exercise session length (before COVID-19) | 5.88 | 0.05 |
| Change in exercise session length | 7.3 | 0.03 |
| Exercise location (gym/home/park/estate/mix) before COVID-19 | 14.9 | 0.01 |
| Current exercise location (gym/home/park/estate/mix) | 12.0 | 0.02 |
| Pre-COVID exercise type (running/ball games/walking/gymnastics) | 50.7 | <0.001 |
| Preferred exercises (run/ball games/walk/gymnastics) currently | 36.9 | <0.001 |
| Preferred day of workout before COVID-19 | 1.94 | 0.38 |
| Preferred day of workout currently | 5.23 | 0.07 |
| Preferred time-of-day for workout before COVID-19 | 10.3 | 0.02 |
| Preferred time-of-day for workout currently | 8.9 | 0.03 |
| Change in time spent sitting/reclining since COVID-19 | 0.79 | 0.68 |

https://doi.org/10.1371/journal.pgph.0000339.t005
compared to group/gym sessions for males. Males were however more likely to have vigorous-intensity PAs compared to mild-to-moderate intensities for females and were 5 times more likely to achieve WHO recommendations for vigorous-intensity PA. They were also 1.6 times more likely to achieve moderate-intensity PA recommendations compared to their female counterparts. There however was no significant association between sex and awareness of WHO recommendations for PA or participation in the same. Previous research has shown that males reduced vigorous-intensity PA while females increased moderate-intensity PA after COVID-19 [45]. Our current work however, adds that males and females maintained their PA intensity preferences even with reported overall decline in PA involvement after COVID-19. Before COVID-19, being male was associated with longer average sessions of PA, but this ceased with the start of the pandemic resulting in a significant drop in time taken per PA session. This differed from females who managed to maintain their pre-COVID-19 session lengths. Recent research has shown that the pandemic has negatively impacted the types and intensities of PA with which individuals engage, and daily sitting time has increased [45]. Except for exercise intensity, there has not been any segregation based on sex and age that we are aware of [44, 45]. Our study attempts to segregate by sex, with additional variables. Concerning the venue for PAs, both males and females maintained their preference for gym setup. Additionally, males seemed to maintain mixed-type PA, running and ball games while females maintained indoor (home) activities, walking and indoor aerobics. The current study also found that being male was associated with planned (either morning or evening) PA while being females was associated with PA only as time became available, without prior planning both before and after the start of COVID-19.

Limitations

The cross-sectional design employed in the current study was unable to assess the actual effect of COVID-19 on PA participation. Our attempt to handle this may have introduced a recall bias that might have affected the data for the period before COVID-19. We attempted to reduce this by including only those questions we thought had minimal recall challenges, but we note that this may not have totally eliminated the bias.

Conclusions

A majority of the urban population of Eldoret, Kenya and especially those with lower level of education were unaware of the WHO recommendations for PA and 30% of them have not engaged in any PA for years. For those reporting participation in PA, the majority do not achieve the recommended WHO threshold levels. COVID-19 has reduced participation in PA and increased the time spent sitting/reclining especially for individuals in higher socio-economic class and for females.

Supporting information

S1 Data.
(XLSX)

Author Contributions

Conceptualization: Karani Magutah.
Data curation: Karani Magutah.
Formal analysis: Karani Magutah, Grace Mbuthia.
Funding acquisition: Karani Magutah.
Investigation: Karani Magutah.
Methodology: Karani Magutah.
Project administration: Karani Magutah.
Resources: Karani Magutah.
Software: Karani Magutah.
Supervision: Karani Magutah.
Validation: Karani Magutah.
Visualization: Karani Magutah.
Writing – original draft: Karani Magutah, Grace Mbuthia.
Writing – review & editing: Karani Magutah, Grace Mbuthia.

References
1. World Health Organization (2010) Global Recommendations on Physical Activity for Health.
2. Warburton DER, Bredin SSD (2017) Health benefits of physical activity: a systematic review of current systematic reviews. Curr Opin Cardiol 32: 541–556. https://doi.org/10.1097/HCO.0000000000000437 PMID: 28708630
3. Nuzum H, Stickel A, Corona M, Zeller M, Melrose RJ, Wilkins SS (2020) Potential Benefits of Physical Activity in MCI and Dementia. Behav Neurol 2020: 7807568. https://doi.org/10.1155/2020/7807568 PMID: 32104516
4. Magutah K, Meiring R, Patel NB, Thairu K (2018) Effect of short and long moderate-intensity exercises in modifying cardiometabolic markers in sedentary Kenyans aged 50 years and above. BMJ Open Sport Exerc Med 4: e000316. https://doi.org/10.1136/bmjsem-2017-000316 PMID: 29719726
5. Magutah K, Patel NB, Thairu K (2018) Effect of moderate-intensity exercise bouts lasting <10 minutes on body composition in sedentary Kenyan adults aged > = 50 years. BMJ Open Sport Exerc Med 4: e000403. https://doi.org/10.1136/bmjsem-2018-000403 PMID: 30305924
6. Onywera VO, Adamo KB, Sheel AW, Waudo JN, Boit MK, Tremblay M (2012) Emerging evidence of the physical activity transition in Kenya. J Phys Act Health 9: 554–562. https://doi.org/10.1123/jpah.9.4.554 PMID: 21946838
7. Ojiambo RM, Easton C, Casajus JA, Konstabel K, Reilly JJ, Pitsiladis Y (2012) Effect of urbanization on objectively measured physical activity levels, sedentary time, and indices of adiposity in Kenyan adolescents. J Phys Act Health 9: 115–123. https://doi.org/10.1123/jpah.9.1.115 PMID: 22232497
8. Wachira LM, Muthuri SK, Ochola SA, Onywera VO, Tremblay MS (2018) Screen-based sedentary behaviour and adiposity among school children: Results from International Study of Childhood Obesity, Lifestyle and the Environment (ISCOLE)—Kenya. PLoS One 13: e0199790. https://doi.org/10.1371/journal.pone.0199790 PMID: 29953496
9. Ssewanyana D, Abubakar A, van Baar A, Mwangala PN, Newton CR (2018) Perspectives on Underlying Factors for Unhealthy Diet and Sedentary Lifestyle of Adolescents at a Kenyan Coastal Setting. Front Public Health 6: 11. https://doi.org/10.3389/fpubh.2018.00011 PMID: 29479525
10. Magutah K, Patel NB, Thairu K (2016) Majority of Elderly Sedentary Kenyans Show Unfavorable Body Composition and Cardio-Metabolic Fitness. J Aging Sci 4:160
11. Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. (2011) American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. Med Sci Sports Exerc 43: 1334–1359. https://doi.org/10.1249/MSS.0b013e318213fe8b PMID: 21694556
12. Chodzko-Zajaiko WJ, Proctor DN, Fiatarone Singh MA, Minson CT, Nigg CR, Saleem GJ, et al. (2009) American College of Sports Medicine position stand. Exercise and physical activity for older adults. Med Sci Sports Exerc 41: 1510–1530. https://doi.org/10.1249/MSS.0b013e3181a0c95c PMID: 19516148
13. Polero P, Rebollo-Seco C, Aduas JC, Pérez-Gómez J, Rojo-Ramos J, Manzano-Redondo F, et al. (2020) Physical Activity Recommendations during COVID-19: Narrative Review. Int J Environ Res Public Health 18. https://doi.org/10.3390/ijerph18010065 PMID: 33374109

14. Nyenhuis SM, Greiwe J, Zeiger JS, Nanda A, Cooke A (2020) Exercise and Fitness in the Age of Social Distancing During the COVID-19 Pandemic. J Allergy Clin Immunol Pract 8: 2152–2155. https://doi.org/10.1016/j.jaip.2020.04.039 PMID: 32360185

15. Schwendinger F, Pacecco E (2020) Countering Physical Inactivity during the COVID-19 Pandemic: Evidence-Based Recommendations for Home-Based Exercise. Int J Environ Res Public Health 17. https://doi.org/10.3390/ijerph17113909 PMID: 32492778

16. Ruiz-Rosero MB, Knott-Torcal C, Matilla-Escalante DC, García-Martín A, Dávalos A, et al. (2020) COVID-19 Lockdown and Changes of the Dietary Pattern and Physical Activity Habits in a Cohort of Patients with Type 2 Diabetes Mellitus. Nutrients 12.

17. Ghosh A, Arora B, Gupta R, Anoop S, Misra A (2020) Effects of nationwide lockdown during COVID-19 epidemic on lifestyle and other medical issues of patients with type 2 diabetes in north India. Diabetes Metab Syndr 14: 917–920. https://doi.org/10.1016/j.dsx.2020.05.044 PMID: 32574982

18. BeLue R, Okoror TA, Iwelunmor J, Taylor KD, Degboe AN, Agyemang C, et al. (2009) An overview of cardiovascular risk factor burden in sub-Saharan African countries: a socio-cultural perspective. Global Health 5: 10. https://doi.org/10.1186/1744-8603-5-10 PMID: 19772644

19. Ikem I, Sumpio BE (2011) Cardiovascular disease: the new epidemic in sub-Saharan Africa. Vascular Health 19: 301–307. https://doi.org/10.1258/vasc.2011.ra0049 PMID: 21940758

20. van der Sande MA (2003) Cardiovascular disease in sub-Saharan Africa: a disaster waiting to happen. Neth J Med 61: 32–36. PMID: 12735418

21. Hendriks ME, Wit FW, Roos MT, Brewster LM, Akande TM, de Beer IH, et al. (2012) Hypertension in sub-Saharan Africa: cross-sectional surveys in four rural and urban communities. PLoS One 7: e32638. https://doi.org/10.1371/journal.pone.0032638 PMID: 22427857

22. Flanagan EW, Beyl RA, Fearnbach SN, Altazan AD, Martin CK, Redman LM (2021) The Impact of COVID-19 Stay-At-Home Orders on Health Behaviors in Adults. Obesity (Silver Spring) 29: 438–445. https://doi.org/10.1002/oby.23066 PMID: 33043562

23. Almandoz JP, Xie L, Schellinger JN, Mathew MS, Gazda C, Ofori A, et al. (2020) Impact of COVID-19 stay-at-home orders on weight-related behaviours among patients with obesity. Clin Obes 10: e12386. https://doi.org/10.1111/cob.12386 PMID: 32515555

24. Zapata-Lamana R, Poblete-Valderrama F, Cigarroa I, Parra-Rizo MA (2021) The Practice of Vigorous Physical Activity Is Related to a Higher Educational Level and Income in Older Women. Int J Environ Res Public Health 18. https://doi.org/10.3390/ijerph182010815 PMID: 34682560

25. Huikari S, Junttila H, Ala-Mursula L, Jäämsä T, Korpelainen R, Miettunen J, et al. (2021) Leisure-time physical activity is associated with socio-economic status beyond income—Cross-sectional survey of the Northern Finland Birth Cohort 1966 study. Econ Hum Biol 41: 100969. https://doi.org/10.1016/j.ehb.2020.100969 PMID: 33429255

26. Nicolson G, Hayes C, Darker C (2019) Examining total and domain-specific sedentary behaviour using the socio-ecological model—a cross-sectional study of Irish adults. BMC Public Health 19: 1155. https://doi.org/10.1186/s12889-019-7447-0 PMID: 31438911

27. Puciatò D, Rozpara M, Mynarski W, Olesniewicz P, Markiewicz-Pathkowska J, Dębiska M (2018) Physical Activity of Working-Age People in View of Their Income Status. Biomed Res Int 2018: 8298527. https://doi.org/10.1155/2018/8298527 PMID: 30515414

28. Scholes S, Mindell JS (2020) Inequalities in participation and time spent in moderate-to-vigorous physical activity: a pooled analysis of the cross-sectional health surveys for England 2008, 2012, and 2016. BMC Public Health 20: 361. https://doi.org/10.1186/s12889-020-08479-x PMID: 32192444

29. DiPietro L, Al-Ansari SS, Biddle SJH, Borodulin K, Bull FC, Buman MP, et al. (2020) Advancing the global physical activity agenda: recommendations for future research by the 2020 WHO physical activity and sedentary behavior guidelines development group. Int J Behav Nutr Phys Act 17: 143. https://doi.org/10.1186/s12966-020-01042-2 PMID: 33239105

30. Magutha K, Thairu K, Patel N (2020) Effect of short moderate intensity exercise bouts on cardiovascular function and maximal oxygen consumption in sedentary older adults. BMJ Open Sport Exerc Med 6: e000672. https://doi.org/10.1136/bmjsem-2019-000672 PMID: 32180993

31. Macfarlane DJ, Taylor LH, Cuddihy TF (2006) Very short intermittent vs continuous bouts of activity in sedentary adults. Prev Med 43: 332–336. https://doi.org/10.1016/j.ypmed.2006.06.002 PMID: 16875724
32. Miyashita M, Burns SF, Stensel DJ (2011) Accumulating short bouts of running reduces resting blood pressure in young normotensive/pre-hypertensive men. J Sports Sci 29: 1473–1482. https://doi.org/10.1080/02640414.2011.593042 PMID: 21988649

33. Quinn TJ, Klooster JR, Kenefick RW (2006) Two short, daily activity bouts vs. one long bout: are health and fitness improvements similar over twelve and twenty-four weeks? J Strength Cond Res 20: 130–135. https://doi.org/10.1519/R-16394.1 PMID: 16506860

34. Fearnbach SN, Flanagan EW, Höchsmann C, Beyl RA, Altazan AD, Martin CK, et al. (2021) Factors Protecting against a Decline in Physical Activity during the COVID-19 Pandemic. Med Sci Sports Exerc. https://doi.org/10.1249/MSS.0000000000002602 PMID: 3349607

35. McCarthy H, Potts HWW, Fisher A (2021) Physical Activity Behavior Before, During, and After COVID-19 Restrictions: Longitudinal Smartphone-Tracking Study of Adults in the United Kingdom. J Med Internet Res 23: e23701. https://doi.org/10.2196/23701 PMID: 33347421

36. Yang Y, Koenigstorfer J (2020) Determinants of physical activity maintenance during the Covid-19 pandemic: a focus on fitness apps. Transl Behav Med 10: 835–842. https://doi.org/10.1093/tbmt/ibaa086 PMID: 32926160

37. Ministry of Health (2020) INTERIM GUIDELINES ON MANAGEMENT OF COVID-19 IN KENYA.

38. Bentlage E, Ammar A, How D, Ahmed M, Trabelsi K, Chitourou H, et al. (2020) Practical Recommendations for Maintaining Active Lifestyle during the COVID-19 Pandemic: A Systematic Literature Review. Int J Environ Res Public Health 17. https://doi.org/10.3390/ijerph17176265 PMID: 32872154

39. Nambakai JE, Kamau J, Amusa LO, Goon DT, Andanje M (2011) Factors influencing participation in physical exercise by the elderly in Eldoret West District, Kenya. African Journal for Physical, Health Education, Recreation and Dance (AJPHED) Vol. 17, No.3.: 462–472.

40. Wong MK, Cheng SYR, Chu TK, Lee CN, Liang J (2017) Hong Kong Chinese adults’ knowledge of exercise recommendations and attitudes towards exercise. BJGP Open 1: bjgpopen17X100929. https://doi.org/10.3399/bjgpopen17X100929 PMID: 30564666

41. World Health Organization (2020) https://www.who.int/news-room/fact-sheets/detail/physical-activity.

42. Martins TCR, Pinho L, Brito M, Penas DG, Silva RRV, Guimarães ALS, et al. (2020) Influence of socioeconomic status, age, body fat, and depressive symptoms on evel of physical activity in adults: a path analysis. Cien Saude Colet 25: 3847–3855. https://doi.org/10.1590/1413-812320202510.24742018 PMID: 32997017

43. Carvalho VO, Gois CO (2020) COVID-19 pandemic and home-based physical activity. J Allergy Clin Immunol Pract 8: 2833–2834. https://doi.org/10.1016/j.jaip.2020.05.018 PMID: 32470443

44. Carvalho VO, Gois CO (2020) COVID-19 pandemic and home-based physical activity. J Allergy Clin Immunol Pract 8: 2833–2834. https://doi.org/10.1016/j.jaip.2020.05.018 PMID: 32470443

45. Freiberg A, Schubert M, Romero Starke K, Hegewald J, Seidler A (2021) A Rapid Review on the Influence of COVID-19 Lockdown and Quarantine Measures on Modifiable Cardiovascular Risk Factors in the General Population. Int J Environ Res Public Health 18. https://doi.org/10.3390/ijerph18186856 PMID: 34443416

46. Clemente-Suárez VJ, Beltrán-Velasco AI, Ramos-Campo DJ, Mielgo-Ayuso J, Nikolaidis PA, Belando N, et al. (2021) Physical activity and COVID-19. The basis for an efficient intervention in times of COVID-19 pandemic. Physiol Behav 244: 113667. https://doi.org/10.1016/j.physbeh.2021.113667 PMID: 34861297

47. Hall G, Laddu DR, Phillips SA, Lavie CJ, Arena R (2021) A tale of two pandemics: How will COVID-19 and global trends in physical inactivity and sedentary behavior affect one another? Prog Cardiovasc Dis 64: 108–110. https://doi.org/10.1016/j.pcad.2020.04.005 PMID: 32277997

48. Sonza A, Da Cunha de Sá-Caputo D, Bachur JA, Rodrigues de Araújo MDG, Valadares Trippe KVT, Ribeiro Nogueira da Gama D, et al. (2020) Brazil before and during COVID-19 pandemic: Impact on the practice and habits of physical exercise. Acta Biomed 92: e2021027. https://doi.org/10.23750/abm.v92i1.10803 PMID: 33682804