REVIEW ARTICLE

A Scoping Review of the Changes in Physical Activity and Sedentary Behaviour and its Health Outcomes among Adults in Asia during the COVID-19 Outbreak

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ABSTRACT

The coronavirus disease (COVID-19) outbreak has led to imposed movement restrictions and lockdowns to curb the spread of COVID-19 cases in the community. These lockdowns had greatly changed people's daily lives, including physical activity and sedentary behaviour. The aim of this scoping review was to establish available evidence linked to physical activity (PA) and sedentary behaviour (SB) among adults in the Asia region during the COVID-19 outbreak. This scoping review was conducted using Arksey & O'Malley's protocol with 132 studies included after full-text screening. Changes in PA were reported in 122 studies and SB in 50 studies. Most studies reported a reduction in the total level of PA and a hike in sedentary and screen time. This decrement in PA and increment in SB was related to poor mental health, body weight increase and complications in COVID-19 patients, while participants who maintained or improved their PA reported better health outcomes.
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INTRODUCTION

The coronavirus disease 2019 (COVID-19) is a pandemic viral disease caused by a virus known as Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) that was initially detected in December 2019 in Wuhan, China and has since spread worldwide (1). The virus can be transmitted through coughing, sneezing or via airborne particles and droplets, resulting in morbidity and mortality (2). The COVID-19 transmission is exceptionally rapid, which has led the governments to impose several restrictions and forced isolation measures to control the spread of COVID-19 cases throughout the population. Some of these restrictions included the closure of workplaces, universities, sports and fitness centers, suspension of outdoor physical activity and social isolation (3).

The pandemic and its various restrictions to curb the spread of the disease had detrimental impacts on physical activity globally (4-5). Regardless of age, health status or geographic locations, a significant decline in physical activity along with increased sedentarism levels was found before COVID-19 periods compared to COVID-19 lockdowns and post-COVID periods (6). The recent pandemic has created more attention in the benefits of physical activity for infectious diseases, including decreased risk of infection, enhanced immune function to promote recovery from infections, and increased effectiveness of vaccines (7). There is emerging evidence on the advantages of physical activity that are specific to severe COVID-19 outcomes such as hospitalisation, intensive care unit admission, or mortality (6,7). Physical inactivity was one of the strongest risk factors to severe COVID-19 outcomes besides old age and history of organ transplant (7). COVID-19 patients who were typically physical inactive were at higher risk of hospitalisation, ICU admission and death from COVID-19 outcomes compared to patients who had regularly achieved physical activity recommendations (7).

The pandemics of non-communicable diseases (NCDs), COVID-19 and physical inactivity have coincided with their adverse long-term health consequences still unknown (6). The adverse long-term health consequences of the concurrence of the non-communicable diseases

(NCDs), COVID-19 and physical inactivity pandemics are still unknown (6). Although there is mounting evidence of the advantages of PA on mental and physical health and well-being (8), there is also a need for a summary paper which identifies and incorporates what is currently known about physical activity and sedentary behaviour changes during COVID-19 outbreak and the associated health outcomes across Asia. Hence, the objective of this study was to prepare a broad scoping to identify the available evidence related to PA and SB changes and its health outcomes published since WHO declared the pandemic. Specifically, we aim to answer the following research questions: [1] What are the available evidence and range of outcomes related to PA and SB among adults in Asia during the COVID-19 outbreak?, [2] What is known about the effects of PA and SB on health among adults in Asia during the COVID-19 outbreak?, and [3] What are the evidence gaps in the current literature?

METHODOLOGY

Scoping review protocol and registration

This scoping review was conducted based on the five-stage framework outlined in Arksey and O'Malley with enhancement by Levac et al and Colquhoun et al (9,10,11). The Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist was used as guidance on the scoping reviews reporting (12). The protocol for this scoping review was registered in the Open Science Framework (OSF) (13) and International Platform of Registered Systematic Review and Meta-analysis Protocols (INPLASY202240023) and is available in full on the inplasy.com website (https://doi.org/10.37766/inplasy2022.4.0023). This review had obtained the approval of the International Medical University's (IMU) Joint Research and Ethics Committee (Project ID No. BDN I-2021 (12)).

Search strategy

We searched the following databases: PubMed, ScienceDirect, Scopus and EBSCOhost (Medline) from 7 Jan 2022 to 13 Jan 2022. No relevant studies were found on the Ovid database.

Eligibility criteria

The following criteria were applied to determine study eligibility: studies related to any form of PA and SB in Asia during the COVID-19 pandemic; involving adults aged from 18 to 65 years old; published peer-reviewed studies in the English language from 2020 to 2022; and available original articles with full text (cross-sectional, prospective studies or retrospective cohort studies, randomised clinical trials and mixed-method (qualitative and quantitative) study designs). Unpublished articles, non-scientific publications, reviews or meta-analyses, or non-original data articles (e.g., letters, commentary, case reports, short communications and comments) were excluded.

Stage 1: Identifying the research questions

The aim of our study was to provide a broad overview of what is known about PA and SB during the COVID-19 pandemic in Asia. Three research questions were identified to address this aim.

1. What are the available evidence and range of outcomes related to physical activity and sedentary behaviour among adults in Asia during the COVID-19 pandemic?
2. What is known about the effects of physical activity and sedentary behaviour on health among adults in Asia during the COVID-19 pandemic?
3. What are the evidence gaps in the current literature?

Stage 2: Identifying relevant studies

Relevant studies were identified using a comprehensive database search strategy developed by the authors. The electronic databases (PubMed, ScienceDirect, Scopus, and EBSCOhost (Medline)) were searched from 7 Jan 2022 to 13 Jan 2022. The search strategy was guided and structured by PICO mnemonic (Population: Adults aged 18 to 65 with or without diseases, Intervention: Studies should have specifically observed the effects of COVID-19 on PA and SB, Comparison: Physical activity adequacy, Outcome: PA and SB levels and health outcomes).

Boolean operator, Medical Subject Heading (MesH Terms), and relevant keywords linked to physical activity (exercise OR physical exercise OR motor activity) AND sedentary behaviour (sedentary lifestyle OR physical inactivity OR screen time OR sitting time) AND COVID-19 (COVID-19 pandemic OR coronavirus disease OR SARS-CoV2 infection) were combined to carry out the search. Truncations and wildcards were utilised whenever possible.

Stage 3: Selection of study

All identified studies were uploaded to the Covidence software Version 2.1 (Veritas Health Innovation, Melbourne, Australia), where duplicates were automatically removed during the uploading process. Titles and abstracts were 100% double screened by LKM and HYC based on inclusion criteria and eligibility, while YYL resolved the conflicts. Full text level reviewing was conducted based on the inclusion and exclusion criteria by two independent researchers (LKM and HYC), with conflicts resolved by a third researcher (YYL, KSK or WAMWM).

Stage 4: Charting of data

Data from the full text review was extracted and entered into a data charting form using Microsoft Excel. The data charted comprised of all the following:

- General study information including author, title, study location, study design, sample size, and participant information

- Study description and main findings
- Measurements of PA and SB (instruments and tools)
- Changes in PA and SB (e.g., scores, levels)
- Health outcomes resulting from changes in PA and SB

Stage 5: Collating, summarising and reporting the results

Findings from this scoping review were summarised and reported in two ways: (1) through an analysis describing information into extent, nature and distribution of the included studies, and (2) through a narrative report summarising the evidence base. The data gathered from the identified studies were summarised into a table and were descriptively analysed. The findings were discussed to answer the research questions and to maximise its importance for researchers, practitioners and stakeholders. In accordance with the guidelines of a scoping review, the studies were not assessed for quality and the purpose was to identify the nature of the research being undertaken.

RESULTS

Descriptive numerical analysis

Overall, the database search yielded a total of 9078 references. A total of 7579 studies were included in the title and abstract screening after 1058 duplicates were removed through the ScienceDirect database and 441 duplicates were removed automatically through the Covidence software. Subsequent to title and abstract screening, 7100 studies were excluded. Full text screening was carried out on the remaining 479 studies. Out of these 479 studies, another 347 studies were excluded based on the reasons outlined in Figure 1. The remaining 132 studies were included in this scoping review. Figure 1 represents the search and selection of the studies in the PRISMA flow chart.

The methodological characteristics of the included studies are presented in Table I. Of these 132 studies, most were cross-sectional (n=102), followed by cohort (n=7), retrospective (n=6), and longitudinal (n=3) study designs. A total of 23 countries in Asia were represented in this study: China (n=35), Japan (n=16), India (n=10), Saudi Arabia (n=10), Turkey (n=8), Korea (n=6), Israel (n=4), United Arab Emirates (n=4), Vietnam (n=4), Bangladesh (n=3), Malaysia (n=3), Singapore (n=3), Taiwan (n=3), Pakistan (n=3), Thailand (n=3), Iran (n=2), Indonesia (n=2), Kuwait (n=2), Qatar (n=2), Sri Lanka (n=2), Brunei (n=1), Jordan (n=1), Lebanon (n=1), and four were conducted in multiple countries including Asia countries. Data collection was conducted in a community setting (n=87) followed by an institutional setting (n=24) and a health care setting (n=21) within the months of March, April, and May 2020, which were the months following the announcement of the pandemic. More than half of the studies (n=69) had a sample size of more than 1001 participants.

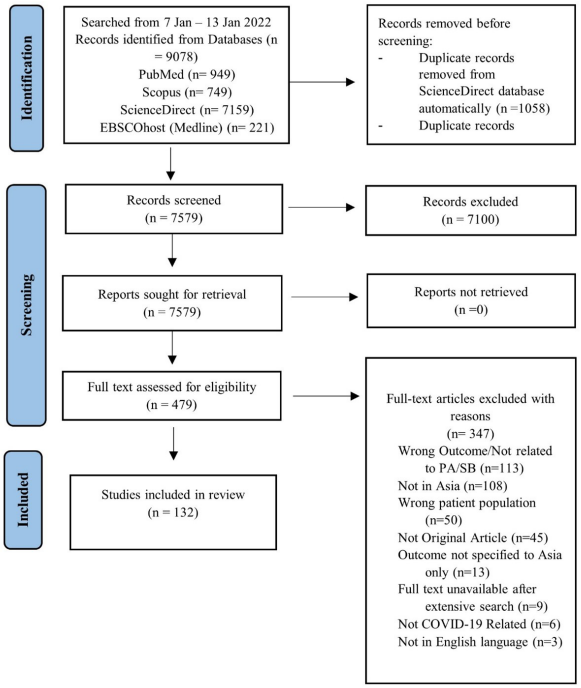

Figure 1: PRISMA study selection flowchart (12)

Narrative summary of findings

This scoping review paper described the included studies (n=132) reporting on these outcomes: measurement tools of PA and SB, changes in PA and SB including levels and scores, and health outcomes resulting from the changes in PA and SB (Table II).

Physical Activity and Sedentary Behaviour Measurements and Tools

All 132 studies examined PA and SB using subjective measurements of PA which include various types of online PA questionnaires. The descriptions of the measurements are presented in Table III. Most of the studies (n=112, 84.8%) had measured PA and SB with the same measurement or questionnaire, for instance, 30 studies had utilised the International Physical Activity Questionnaire – Short Form (IPAQ-SF) to assess both PA and SB. Only 12 studies (9.1%) have used the objective measurement of PA (accelerometer, pedometer, GPA signal, wearable fitness tracker, health tracking application), while 5 studies (3.7%) carried out PA programmes during the COVID-19 pandemic to evaluate the impact of PA on health during this period.

Physical Activity and COVID-19 Pandemic

A total of 122 studies have examined the changes in PA after the COVID-19 outbreak, which is reported as total PA increased, decreased or no change and measured in the form of mins/week, hours/day, days/week, MET-min/week or in the percentage (%) of the respective study.

Physical Activity among Healthy Adults

Of the 122 studies, 87 studies (71.3%) have measured PA among healthy adults which involved the general

Table I: Characteristics of the included studies (n=132)

Characteristic	Categories	n (%)
Study design	Cross-sectional	102 (77.2%)
	Cohort	7 (5.3%)
	Retrospective	6 (4.5%)
	Longitudinal	3 (2.3%)
	Randomised control trial	2 (1.5%)
	Retrospective observational	2 (1.5%)
	Prospective	2 (1.5%)
	Others (Quasi-experimental, case-control, qualitative)	8 (6.2%)
Country	China	35 (26.5%)
	Japan	16 (12.1%)
	India	10 (7.6%)
	Saudi Arabia	10 (7.6%)
	Turkey	8 (6.1%)
	Korea	6 (4.5%)
	Israel	4 (3%)
	United Arab Emirates	4 (3%)
	Vietnam	4 (3%)
	Bangladesh	3 (2.3%)
	Malaysia	3 (2.3%)
	Singapore	3 (2.3%)
	Taiwan	3 (2.3%)
	Pakistan	3 (2.3%)
	Thailand	3 (2.3%)
	Iran	2 (1.5%)
	Indonesia	2 (1.5%)
	Kuwait	2 (1.5%)
	Qatar	2 (1.5%)
	Sri Lanka	2 (1.5%)
	International (Brazil, Bulgaria, China, India, Ireland, Malaysia, North Macedonia, Singapore, Spain, Turkey, and the United States)	1 (0.8%)
	International (Slovenia, Czech Republic, Germany, Poland, Ukraine, Russia, Turkey, Israel, and Colombia	1 (0.8%)
	Brunei	1 (0.8%)
	Jordan	1 (0.8%)
	Lebanon	1 (0.8%)
	South Asia (Bangladesh, South India, North India, Pakistan, and Sri Lanka)	1 (0.8%)
	Malaysia and Indonesia	1 (0.8%)
Study population	General adult population	51 (38.6%)
	University/College students	23 (17.4%)
	Adults with/without chronic disease	17 (12.8%)
	Workers	8 (6.0%)
	COVID-19 patients	8 (6.0%)
	Diabetes patients	8 (6.0%)
	Pregnant women	3 (2.3%)
	Athletes	2 (1.5%)
	Outpatients	2 (1.5%)
	Teachers	2 (1.5%)
	Heart Failure patients	1 (0.8%)
	Multiple sclerosis disease patients	1 (0.8%)
	Postmenopausal women	1 (0.8%)
	Overweight/Obese patients	1 (0.8%)
	Orthopedic patients	1 (0.8%)
	Adults with high mental risk	1 (0.8%)
	Retired employee	1 (0.8%)
	Caregivers	1 (0.8%)
Sample size	10-100	12 (9.1%)
	101-500	29 (22.0%)
	501-1000	22 (16.7%)
	1001 and above	69 (52.2%)

Note: Percentage may not add up to 100% due to rounding.

adult population, university or college students, or workers in a given industry or occupation. Of these, 44 studies have found that the total PA level has decreased during the COVID-19 pandemic. When stratifying across the PA intensity, three studies have reported decreased light physical activity level (LPA) (16,46,80) and a decrease in moderate physical activity (MPA) (71,76,121), respectively. Two studies reported a decrease in moderate-vigorous physical activity (MVPA) (115,133) and a decrease in light-moderate-vigorous physical activity (LMVPA) (102,142). Ten studies that used objective measurement tools have found that daily steps count have decreased (29,36,37,78,92,98,100,111,126,128). In addition, several studies have found that the total PA level has increased during the pandemic. One study reported participants engaged in more MPA (41), more vigorous physical activity (VPA) (20), and one study among college students had increased PA and met the MVPA guidelines (79). Moreover, four studies found that PA among adults did not change during the COVID-19 pandemic (27,31,70,119).

Physical Activity among Adults with Special Considerations and Medical Conditions

Changes in PA during the COVID-19 were also observed among adults with special considerations or medical conditions. A total of 35 (29.5%) studies have examined PA among these groups. Of these, 18 studies reported total PA level have decreased among patients with or without chronic disease(s) (40,43,65,91,123,131,134), diabetes patients (39,86,99,135), COVID-19 patients (21,124,123), heart failure patients (17), multiple sclerosis patients (64), orthopedic patients (118), and adults with pain (55,136). When stratifying across the PA intensity, one study among postmenopausal women had lower levels of PA (68), three other studies reported low MVPA among adults with or without the chronic disease (66) and COVID-19 patients (62,75), and one study reported a decrease in LMVPA among adults with or without the chronic disease (127). On the other hand, eight studies have reported total PA level has increased during the pandemic among diabetes patients (48,105,132), adults with or without the chronic disease (82,117), overweight and obese (89), outpatients (95), and pregnant women (57). One study among adults with chronic diseases engaged in higher LMVPA due to the fear of getting COVID-19 (24). The remaining three studies among obese (18), pregnant women (56), and diabetes (110) have reported no difference in PA levels during the COVID-19 outbreak and pandemic as compared with a pre-pandemic state.

Sedentary Behaviour During the COVID-19 Pandemic

From the 132 studies included, 50 studies have examined changes in SB. Of these, 21 (42%) were conducted among the general adult population, and 15 (30%) among university or college students. Only 8 (16%) were conducted among adults with or without chronic diseases, while another 6 studies were conducted on workers (n=4, 8%) and pregnant women (n=2, 4%), respectively. Online questionnaire and IPAQ-SF were mainly utilised as SB measurement tool, and only three studies have specified the measurement used for SB, such as the Sedentary Behaviour Questionnaire (SBQ) and the Japanese 6-items Questionnaire that has a one-week recall period (71,72,142). Furthermore, most of the studies reported SB in the form of screen time (40%), sedentary time (38%), and sitting time (30%). SB was assessed in terms of percentage (%), hours/day/week, or

Table II: Summary of the included studies (n=132)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Abdulsalam et al, 2021. [14]	Saudi Arabia Community	General adult population, aged 19-59	Normal daily activity levels significantly decreased during the COVID-19 period, and the lockdown has resulted in an increase in screen-based activities which increased the body weight.	- The number of people practicing PA at least 4 h/week before the COVID-19 pandemic decreased from 8.7% to 5.3%. during the pandemic - The number of people who did not do any PA increased from 31.6% to 35.2%.	Respondents who spent >6 h/day using computers/mobile devices during the COVID-19 pandemic increased significantly from 12.5% to 36.2%.	42.9% of the participants who spent >6 h in front of the computer/phone/TV screen, body weight increased
Ahmad Ali et al, 2021. [15]	Pakistan Community	General adult population, aged 18-65	Participants' PA has reduced, and 38.8% of the participant's weight increased during the COVID-19 lockdown	66.9% of the participants reported a decrease in PA	N/A	A decrease in PA has resulted in an increase in body weight
Aiswarya et al, 2021. [16]	India Community	Handloom workers, aged 30-60	Women's daily moderate working habits shifted to low PA and high SB	-58.8% was involved in VPA for < 1 h -49.4% of women were involved in MPA for 1–2 h -90.2% spent < 1 h on walking.	56% of women spent >4 hours sitting during lockdown	N/A
Al Fagih et al, 2020. [17]	Saudi Arabia Health Care	Heart failure patients, aged 58-72	There was a significant decline in PA among HF patients	27.1% of heart failure patient's PA decreased from 2.4 to 1.8 hours/day	N/A	No significant change in HF patient's health
Al-Domi et al, 2021. [18]	Jordan Community	Adults with/ without disease, aged > 18	There was no significant difference in PA among various weight status groups during the COVID-19 pandemic	-70% reported changes in PA, and 39% of overweight and obese reported inactive. -39.6% participants with normal weight reported doing MPA during the COVID-19	N/A	N/A
Alfawaz et al, 2021. [19]	Saudi Arabia Community	General adult population, aged 15-75 (35.2±13.1)	84.7% did not perform PA at home nor improve their PA habit during quarantine	- Walking daily for >4 times/week decreased by 29.1% - Participants who never performed home PA with weights increased by 44.6%	N/A	N/A
Ali et al, 2021. [20]	Malaysia Community	University students, aged 15- >45years	Restricting individuals from doing out-of-home activities negatively influenced physical and social health during the pandemic, while an increase in home maintenance activities resulted in a daily increase of 0.5% in physical health and a unit increase in the in-home activities at leisure time resulted in a 1% positive improvement in social health	Participants aged 15-22 and above 45 years showed the highest involvement in the duration of strenuous-intensity PA at leisure time than the rest of the ages, with time spent of 50 and 56,67 mins/day, respectively	N/A	- Those who spend most of the time working by doing MVPA have better physical and social health conditions than those who have the opposite arrangement - Those who spent more time in-home and have shorter exposure to social activities retain reduced physical and social health conditions than those with the opposite sequence

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
AlKetbi et al, 2021. [21]	United Arab Emirates Health Care	SARS-Cov-2 and non-SARS-Cov-2 patients, - mean age 44 years for severe SARS-CoV-2 patients - mean age 35 years for non-sever category - mean age 32 years for who never admitted	The mortality rate among individuals who exercised for < 30 mins/week was 5.04 %, compared to 0.35 % for those who exercised for > 30 minutes at least once per week.	- 28.3% did 5-7 times PA per week - 36.6% of patients admitted with no severe illness and (34.8%) with severe illness did 1-2 times PA per week	N/A	Mortality increased among patients who reported low PA
Al-Musharaf et al, 2021. [22]	Saudi Arabia Institution	Students/graduates, aged 19-30	During the lockdown, sedentary time increased, and PA decreased in the weight gain group	Women who gained weight did not meet the recommended GPAQ score (<600MET-min/week) during lockdown	Sitting time increased	Women who didn't meet the recommended GPAQ score (<600MET-min/week) experienced weight gain, while the GPAQ score (>600MET-min/week) was a protective factor against weight gain during lockdown
Alotaibi et al, 2021. [23]	Saudi Arabia Community	General adult population, 18-70 years	Physical inactivity has increased and there was a significant difference in BMI between active and inactive participants and the sedentary population had a greater incidence of mild depression than active participants.	Physical inactivity increased by 21% during the lockdown	N/A	A significant relation between inactivity and higher BMI among females - Physically active participants show a lower incidence of moderate depression compared to sedentary behaviour
Alothman et al, 2021. [24]	Saudi Arabia Community	Adults with comorbidities, aged >18	PA was higher due to the increase in fear from COVID-19 and distress. at the same time, there was a high level of SB during the pandemic	9% engaged in high levels of PA, whereas 45.27% engaged in moderate levels and 45.71% in low levels of PA	60.3% of the participants reported sitting for an average of 6 hours/day.	N/A
Alzahrani et al, 2021. [25]	Saudi Arabia Community	Adults with/without chronic disease, aged 23-51	There was a significant increase in HRQoL in highly active and sufficiently active participants compared with inactive participants.	N/A	N/A	-Better HRQoL among highly active participants while HRQoL is worse among inactive participants -Participants engaged in high PA were associated with lower psychological distress than those who were less active
Amini et al, 2020. [26]	Iran Community	General adult population, aged 18-64	The level of PA significantly decreased during COVID-19 compared to pre-COVID-19	- An increase of 27.1% of low active participants - Decrease of 7.7% and 19.4% of moderately and high active participants	N/A	N/A
Auny et al, 2021. [27]	Bangladesh Community	General adult population, mean age (26.99 ± 8.17)	- The majority of the participant's PA levels didn't change during the COVID-19 - Anxiety levels increased among participants that performed more PA	- 44.1% reported no change in performing PA - 38.9% reported a reduction in PA	N/A	Anxiety levels increased among more active participants
Şenışık et al, 2021. [28]	Turkey Community	Professional athletes and non-athlete, aged 18-38	Participants who exercised regularly until the isolation period began may be less mentally affected by this period than those who did not exercise.	Total PA levels were higher in team athletes and non-athletes	N/A	Athletes had lower depression and anxiety symptoms than non-athletes' controls

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Azuma et al, 2021. [29]	Japan Community	General adult population, aged >20 Period A (women 33± 11, Men 39 ± 14) Period B (women 31±10, Men 36± 12)	PA had declined during the pandemic compared with pre-pandemic, especially in men	- Number of steps per day decreased by approximately 20% before the pandemic compared with during the pandemic (4642±3513 vs.3814±3529)	N/A	There was a significant positive association between happiness and steps/day during the pandemic
Bakhsh et al, 2021. [30]	Saudi Arabia Community	General adult population, aged > 18, age 30-39	- Majority of the participants did not perform any PA during quarantine - Decreased PA was significantly higher among participants who reported weight gain	- 52% of participants' PA decreased - 27% of participants' PA increased - 21% of participants PA did not change	N/A	Weight gain was associated with inactivity
Chang et al, 2020. [31]	Taiwan Community	General adult population,mean age 35.90±15.16	The majority of the participants-maintained exercise frequency and participants who exercised >4 days had significantly higher mood states during the pandemic	- 67.3% reported being physically active - 19.7% reported a decrease in exercise frequency - 12.9% reported an increase in exercise frequency	N/A	An increase in the frequency of the exercise was associated with high mood status, while mood status was negatively affected when exercise frequency decreased
Cho et al, 2021. [32]	Korea Health Care	COVID-19 patients, aged >18 [COVID-19 patients (50.7±14.3)] [Controls (50.7±14.3)]	- A 4% reduction in the risk of COVID-19 morbidity was related to an (SD) increase in MET/week - Lower mortality was related to MVPA and an SD increase in (MET/week).	The proportion of (MVPA) was lower in the case patients than in the controls. The mean PA level was lower in the case patients than in the controls (558.2±516.3 MET-min/week vs.580.2±525.7 MET-min/week)	N/A	MVPA was associated with a 10% lower risk of COVID-19 infection and a 53% lower risk of COVID-19 infection-related mortality
Chopra et al, 2020. [33]	India Community	General adult population, aged 18-85 (33±14.5)	- The overall participation in household chores activities significantly increased while participation in leisure-related activities significantly decreased - There is a significant increase in daily settings and screen time during the pandemic	- Participation in moderate-intensity aerobic exercises and leisure related activities declined significantly - 50.5% increase in the number of participants who did not exercise for 30 minutes - 45.2% maintain exercising > 3 days a week during the pandemic	Screen and sitting time significantly increased, and participants reported a daily screen time of 4-5 hours during COVID-19	N/A
Cigrovski et al, 2020. [34]	China and Croatia Institution	University Students, aged >18 (22.30 ± 2.72)	Lockdown has affected the level of PA among students as it was found that the level of total PA MET-min/week and average min of PA/week were significantly lower, while after the lockdown, PA was higher	- Total PA MET-minutes/week median for students was 1805.00 during the lockdown - Total PA MET-minutes/week median for students were 2880.00 after the lockdown	N/A	N/A
Dai et al, 2021. [35]	China Community	General adult population, aged >18 years	The COVID-19 pandemic has impacted PA negatively, resulting in increased physical inactivity	Physical activity decreased during the pandemic	N/A	A decrease in PA resulted in a negative impact on the HRQoL.
Deng et al, 2020. [36]	China Institution	University and college students, aged 18 - >22	Most of the participant's exercise habit was negatively affected by COVID-19 but slightly, and the mental status of the students was significantly correlated with regular exercise and sufficient exercise duration	- 67.7% exercised regularly - 51.4% spent less time on sports - 62.9% exercised <3 times a week - 71.9% of average pedometer steps was <2000	N/A	Exercising regularly (> 1-2 times a week) and had an exercise duration of >1 hour, had >2000 average pedometer steps had a significantly lower score of mental health

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Ding et al, 2021. [37]	China Community	General adult population, aged 20 - >50 (mean 40)	PA reduced during the lockdown, and there was a decrease in daily steps counts by > 40%, followed by a slow, steady increased	- Daily steps decreased by 3796 during the lockdown - Step count increased significantly by 34 steps/day until the end of the lockdown	N/A	N/A
Ding et al, 2021. [38]	International (Brazil, Bulgaria, China, India, Ireland, Malaysia, North Macedonia, Singapore, Spain, Turkey, and the United States) Community	General adult population, aged 18 - >65	Most of the Asian countries reported a decrease in PA, while only Singapore reported the highest proportions of an increased PA level engagement during lockdown	- Insufficiently active during lockdown were seen in countries: Malaysia (55.2%), China (54.4%), and India (51.3%) - Singapore (30.1%) reported an increased PA level engagement during the lockdown.	N/A	N/A
Dissanayake et al, 2022. [39]	Sri Lanka Health Care	Diabetes patients, aged >18 (57.4±13.4)	Time spent in exercise decreased during lockdown while SB increased	43.4% reported a decrease in time spent exercising	41.1% reported an increase in sedentary time (sitting and reclining)	The indoor exercise was associated with improved glycaemic while a decrease in exercise predicted to worsen glycemia
Dor-Haim et al, 2021. [40]	Israel Community	Adults with/without chronic diseases, aged 18-85 (48.52+15.60)	PA level and exercise habits significantly decreased during the COVID-19 lockdown	- 70% reported exercising less than usual, while 63% reported they exercised three times a week or less. - 37.18% of the participants reported exercising 4 times/week as compared to 20.38% (3 times/week), 18.71% (2 times/week), 14.30% (1 day a week)	N/A	Participants who performed higher PA levels reported no weight gain, while exercise 3 times a week or less is associated with increased weight gain
Dun et al, 2021. [41]	China Institution	University students, aged 18 to 21 (20±1)	Aerobic, anaerobic, explosive, and muscular fitness was independently and inversely associated with depression young adults free from chronic disease	- The majority of the participants were between moderate and high fitness during the pandemic - Less than 25% reported low fitness or excellent during the pandemic	N/A	Participants with moderate, high, or excellent anaerobic and aerobic fitness showed a much lower risk of depression during the pandemic, whereas muscular fitness showed a greater effect on the reduction of depression
Dun et al, 2021. [42]	China Institution	College students, aged 17-27	There were significant increases in sedentary time during the lockdown, and it was associated with weight gain	There was a decrease in men's PA and an increase in women's PA	-There was a significant increase in sedentary time in both men and women	sedentary time was significantly associated with weight gain
Elran-Barak et al, 2020. [43]	Israel Community	Patients with chronic disease, aged 18 to >76 years	There was a significant deterioration in health behavior, including a significant decline in PA and an increase in SB	PA has decreased from 3.5±2.4 before lockdown to 2.8±2.4 times/week during the lockdown	SB has increased from 3.2±1.1 before the lockdown to 3.9±1.2h/day during the lockdown	N/A
Fang et al, 2021. [44]	Taiwan Institution	University students, aged 18-23	The majority of the participant's exercise was not regular during the pandemic, and participants in sports was positively related to well-being and quality of life	- 77.8% of students reported their exercise was not regular while 22.2% reported regular exercise - 79.2% were not engaged in interscholastic sports teams, while 20.8% reported being engaged in interscholastic sports team	N/A	PA was positively associated with well-being and quality of life, promoting good mental health during the pandemic

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Feng et al, 2022. [45]	China Community	Parent and primary caregiver, aged > 18 (35.5±4.9)	Engaging in less total PA and high SB is associated with higher levels of depression and anxiety.	N/A	N/A	Higher PA leads to a lower level of depression - Higher SB leads to a higher level of depression and anxiety - Lower SB leads to a lower level of depression, anxiety, and stress
Fukushima et al, 2021. [46]	Japan Community	Workers, aged 20-79 (44±13)	For the workers who work from home (WFH), their PA was low while SB was high compared to no WFH group	Times spent in LPA and MVPA in the WFH group were significantly shorter than those in the no WFH group	Times spent in SB during work time in the WFH group were significantly longer than those in the no WFH group	N/A
Ghani et al, 2021. [47]	Malaysia Community	Adults involved with the group exercise and fitness program, aged 20-29	Virtual physical exercise had improved mental health during the COVID-19 pandemic	N/A	N/A	Mental health (depression, anxiety, and stress) were significantly lowered and improved during the virtual physical exercise
Ghosh et al, 2020. [48]	India Community	T2DM patients, aged <40 - >60	The majority of the participants reported an increase in PA, while participants whose exercise duration decreased led to a reduction in self-monitoring blood glucose (SMBG) and an increment in mental stress	- 42% reported a reduction in exercise - 62% reported an increase in PA and continued exercising - more than a 50% increase in the duration of exercise was reported in 10% of patients.	N/A	A decrease in PA leads to a reduction (SMBG) and increase in mental distress
Gupta et al, 2022. [49]	India Community	College Students, aged 18-30 years	It was found that (43%) of the participant's screen time had increased by 50 -75%, and the increase in screen time was significantly associated with dry eyes during the COVID-19 pandemic	N/A	- 94.5% of the participants have reported their screen time has increased during the pandemic - 45.50% of the participants have spent >6 h daily on-screen, and 33.30% have spent 4 to 6 h daily on screen - 77.7% of the participants have spent most of their time Mobile phone	There is a significant association between dry eye with daily screen time spent
Halabchi et al, 2021. [50]	Iran Health Care	Suspicious, probable, or definite cases of COVID-19, aged 20 to 65 (42.31±11.92)	Poor clinical outcomes are less likely in patients who participate in sports on a regular basis	N/A	N/A	Athletes with regular sports participation were 33% less likely to be hospitalised than nonathletes and 0.8% no death in athletes
Hashim et al, 2021. [51]	United Arab Emirates Health Care	Pregnant women, aged 18-45	PA decreased during the pandemic, and time spent resting and relaxing increased	Time spent exercising was decreased (53.6%).	Time spent resting (55.2%) and relaxing (57.3%) was increased.	N/A
Hashimoto et al, 2021. [52]	Japan Institution	University students, aged >18 (mean age 20)	Lockdown during the COVID-19 pandemic has resulted in a reduction of PA	The average exercise intensity was low from April to June 2020, with a score of 6.5±0.25 compared to July - December with a score of 7.6±0.28 and 9.1±0.37, respectively	N/A	N/A
Hermassi et al, 2021. [53]	Qatar Community	General adult population, aged 18-67 (33.1±11.1)	Confinement resulted in a reduction of all PA levels and an increase in daily sitting time	walking 10 mins per week was decreased from (449±261 MET-mins/week) to (141±87.0 MET-mins/week) for women and (528±271 MET-mins/week) to (215±120 MET-mins/week) in men	Sitting hours per weekday increase from 3.64±1.42 to 6.51±1.22 for males; 3.49±1.53 to 6.12±1.41 for females.	N/A

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Hikmah et al, 2020. [54]	Indonesia Community	General adult population, aged 18-69	During the pandemic, PA intensity decreased, and it was associated with anxiety while screen time increased,	- 62.2% reported a low intensity of PA - 40% reported high intensity of PA	94% of the total participants spent their work time in front of electronic devices during the pandemic, 35.2% with screen time of ≥8 h per day.	Low PA was associated with severe to mild anxiety
Hirase et al, 2021. [55]	Japan Community	Adults with/without pain, 40- >60 (50.5±7.6)	PA was lower among older adults with pain compared with no pain after during, and post COVID-19	With and without pain - Participants aged 40 to 59 years, the total duration of PA was significantly decreased With pain: - Participants with pain in the 60 years group, the total duration of PA significantly decreased	N/A	N/A
Hori et al, 2021. [56]	Japan Health Care	Pregnant woman, aged 20-47	During pregnancy, physical activity levels did not differ regardless of lifestyle changes caused by the COVID-19 pandemic.	- There was no significant difference in PA levels that was associated with lifestyle changes due to the pandemic in both primiparas and multiparas. - no significant differences in PA levels were found between women who reported that their PA was affected by the pandemic and Those who reported it was unaffected.	There was no significant difference between women who reported that their SB was affected by the COVID-19 pandemic and those who reported that it was unaffected.	N/A
Hu et al, 2021. [57]	China Community	Pregnant women, aged >18 [Pregnant women (29.96±3.37)] [Control group (29.90±3.38)]	Pregnant women tend to exercise more than non-pregnant women during the pandemic	30.6% of the pregnant women continued to exercise, while the control group was 8.4%	N/A	N/A
Huang et al, 2020. [58]	China Health Care	Adults infected and non-infected with COVID-19, >18 years (44.29±14.69)	- Irregular exercise and a sedentary lifestyle was associated with increased illness risk - Moderate-intensity PA was more protective against COVID-19 than high-intensity PA	N/A	N/A	physical inactivity and SB increase the risk of illness, while moderate-intensity PA protects against COVID-19
Husain, Ashkanani, 2020. [59]	Kuwait Community	General adult population, aged 18-73 (38.47± 12.73)	A significant reduction in PA during COVID-19, while time spent SB increased	- 39.5% reported not exercising at all - 10% reported exercising in some seasons	Time spent >6 h on TV/computer/phone increased from 16.1% before lockdown to 43.6% after lockdown	N/A
Idris et al, 2021. [60]	Brunei Institution	Undergraduate students and lecturers, aged 18-50	Students have reported a decrease in exercise time while lecturers have more exercise time, although they had more screen time	- 44.8% of students had less time to exercise while 35.8% had exercised more at home - 51.8% of lecturers had more time to exercise	50% of lecturers spent more time on screen	Lectures who reported more screen time have experienced more physical stress
Islam et al, 2020. [61]	Bangladesh Community	General adult population, aged 18-50 (mean 23.1)	Participants engaging in physical exercise was less while playing online videogames, social media use, and engaging in online recreational activities were higher	51.1% engaged in regular exercise	25.3% spent >6 h daily on the internet 31.1% spent 5 to 6 h daily on the internet	depression scores were significantly higher among participants who did not engage in physical exercise, who browsed more on the internet daily (2-4 h), who played online video games, who used social media, who engaged in recreational activities on the internet

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Ismail et al, 2020. [62]	United Arab Emirates Community	General adult population, aged 18- >55	PA decreased, and SB increased during the pandemic, and there was a significant association between PA and weight change	38.5% of the participants reported not engaging in any form of PA during the pandemic	- 47.6% of the participants spent >5 h/day on computer or work - 36.2% of the participants spent >5 h/day on screens	- 40.3% of the participants reported weight gain when they did not perform PA - 29.9% reported weight loss when they performed PA
Jia et al, 2021. [63]	China Community	High schools, colleges, and graduate schools Students, aged (19.8±2.3)	After the COVID-19 lockdown, the frequency of PA has reduced while sedentary and screen time have increased among youths	A significant decrease in the frequency of engaging in active transport (from 1.3 to 0.9 days/week), moderate-/vigorous-intensity house-work (MVH) (from 2.3 to 1.9 days/week), leisure time MVPA (from 0.7 to 0.65 days/week) and leisure time walking (from 1.0 to 0.7 days/week) after lookdown	There was a significant increase in the average sedentary time during workdays (from 4.2 to 5.3 h/week), during weekends (from 4.3 to 5.1 h/week), and screen time (from 4.9 to 5.6 h/week)	N/A
Kalron et al, 2021. [64]	Israel Health Care	Multiple sclerosis disease patients, aged > 18 (43.0±12.9)	For most people with multiple sclerosis leisure-time, PA was decreased or ceased, whereas 38.3% of the patients reported continuing or even performing more PA than usual	- 18.3% reported an increase in PA - 72.1% reported their primary type of PA was aerobic exercise - 60.0% reported no change in their fitness level - 31.7% reported a decrease in fitness level	N/A	N/A
Kang et al, 2021. [65]	Korea Community	Adults with/without chronic disease, aged 19 - >60	It was found that PA decreased more during the pandemic. Even though the majority of the participants reported PA unchanged	74.1% reported unchanged their PA - 15.9% decrease in moderate or high-intensity aerobic exercise - 10% reported an increase in the frequency of exercise after the onset of the pandemic	N/A	An increase in moderate or high-intensity aerobic exercise resulted in improving health behaviors
Katewongsa et al, 2021. [66]	Thailand Community	Adults with/without chronic disease, aged 18-64	There was a significant increase in SB during the pandemic when compared to pre-pandemic	Sufficient MVPA decreased from 74.6% pre-pandemic to 57.0% during the pandemic	- Time spent SB >13h increased from 65.9% pre-pandemic to 69.2% during the pandemic - Significant increase of SB (875min/day) during the pandemic	N/A
Katewongsa et al, 2021. [67]	Thailand Community	Adults with/without chronic disease, aged 18-64	The COVID-19 pandemic adversely affected the PA of the Thai population, where MVPA decreased during the pandemic	- Sufficient MVPA decreased from 74.6% to 54.7% - A reduction in the cumulative minutes of MVPA from 580 min to 420 min	N/A	N/A
Kaygisiz et al, 2020. [68]	Turkey Community	Postmenopausal women, aged 50-75 (59 ± 6.62)	The majority of the participants had a low PA during self-quarantine	30% women were doing exercise during the self-quarantine period of the pandemic. 26% reported doing exercise during the pandemic. Four percent (4%) women started doing exercise during the self-quarantine period.	N/A	A decrease in physical inactivity resulted in an increase in anxiety
Kim et al, 2021. [69]	Korea Community	General adult population, aged >18 (40.3 ± 11.8)	-PA has decreased during the pandemic -Exercise three or more times per week was inversely associated with depression.	The frequency of the participants exercising three times or more per week before the COVID-19 pandemic decreased from 59.7% to 31.1% during the pandemic	N/A	Exercising at least three times weekly or more, less likely to exhibit depression

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Kolokotroni et al, 2021. [70]	Turkey Community	General adult population, aged >18 (median age 39 (IQR: 13))	Physical activity score did not change during lockdown; however, there was an increase in energy expenditure in walking and an increase in sedentary time.	60% of participants did not report any change in PA - 40% were split between increased and decreased activity level - A significant increase in walking during lockdown (one MET - min/week 297 vs. 231) - MET-min/week spent in moderate or vigorous PA was lower among younger adults	Most participants reported increasing SB during lockdown (180 vs.120 min sitting)	Significant but very small negative correlations were observed between differences in PA score and perceived stress
Koohsari et al, 2021. [71]	Japan Community	Workers, aged >18 (9.6±10.7)	An increase in working from home days was significantly associated with a decrease in MPA, increased work-related sitting time, and total sitting time	Moderate PA decreased	Work-related sitting time and total sitting time increased	N/A
Koohsari et al, 2021. [72]	Japan Community	Workers, aged >18 (39.6±10.7)	Sedentary and PA among company workers in Japan have been negatively affected during the COVID-19 outbreak, and an increase in SB contributed to changes in workers' fatigue	- Vigorous leisure PA decreased from 15 to 12 mins/day - Total PA decreased from 1.75 to 1.55 mins/day	Participants spent more sedentary time in work-related sitting time during the workday (5.18 to 5.69) h/day, TV viewing time (1.56 to 1.65) h/day, PC use sitting time (1.36 to 1.47) h/day, and total sitting time during the COVID-19 pandemic (8.96 to 9.53) h/day.	The subscale scores for the motivation and physical activity aspects of fatigue increased by 0.03 for each half-hour increase in total sitting time
Kua et al, 2021. [73]	Singapore Community	Healthcare professionals, aged (37.43±10.23)	There was a significant reduction in weekly exercise frequency, duration, and intensity during the lockdown, and a decrease in exercise was associated with a negative impact on mental health	- 23.2% of the participants did not engage in any MVPA before the lockdown, and this increased by 70% during the lockdown - Majority of the participants 42.5% and 42.8% had reduced their PA frequency and duration, respectively, while 37.3% and 35.0% there is no change in their PA frequency and duration, respectively - 20.3% and 22.2% had increased their PA frequency and duration	N/A	- Those who had reported a 3-day reduction in their weekly PA frequency had the highest rates of depressive symptoms. - The increased number of days spent on MVPA was significantly associated with a decreased likelihood of reporting mild and moderate-to-severe levels of depression, while reduced time spent on MVPA was associated with moderate-to-severe-depressive symptoms and mild stress symptoms
Kusuma et al, 2021. [74]	Bangladesh, South India, North India, Pakistan, and Sri Lanka. Community	Adults with chronic disease, aged >18 (mean 45)	SB has increased during the lockdown among the participants with chronic disease	N/A	32% increase in SB from 3.8 h before lockdown to 5.0 h during lockdown	N/A
Lee et al, 2021. [75]	Korea Community	COVID-19 patients, aged 20-60	Physical activity, including both aerobic and muscle-strengthening exercises, led to substantial reductions in the infectivity of SARS-CoV-2, risk of poor outcomes, and death related to COVID-19.	54.1% adults have insufficient aerobic and muscle strengthening	N/A	Adults who engage in both aerobic and muscle-strengthening activities and the recommended range of metabolic equivalent tasks (MET; 500-1000 MET min/week) have a maximum beneficial effect of lowering the risk of SARS-CoV-2 infection, relative risk, severe Covid-19 illness, and Covid-19 related death

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Lee et al, 2022. [76]	Korea Community	General adult population, aged 19->60	After social distancing due to COVID 19, all subjects' high- and moderate-intensity physical activities decreased	- For high-intensity physical activity, the amount decreased in all groups after the outbreak; the amount decreased by approximately 10-20 min in adult and senior males. - Moderate-intensity physical activity significantly decreased in all groups. The amount decreased by about 25 min in adult males, 50 min in adult females, 20 min in senior males, and 25 min in senior females	N/A	N/A
Li et al, 2021. [77]	China Community	General adult population, aged (mean 33.89)	The COVID-19 lockdowns and self-quarantine have resulted in less exercise time	- Increase in the size of the social network was related to a decrease in exercise time by 0.017 h/day during the outbreak period - When the package delivery restriction increased by one week, exercise time was found to decrease by 0.013 h/day - With one more store nearby, exercise time was observed to increase by 0.015 h per day during the outbreak period.	N/A	N/A
Li et al, 2021. [78]	China Community	General adult population, aged (36± 11.3)	The lockdown significantly restricted general movement, as reflected by the daily steps count	Daily steps decreased substantially by 3352 steps	N/A	Less activity was associated with depression
Liang et al, 2021. [79]	China Institution	College students, aged 18-26	Meeting SB + MVPA guidelines were associated with a significantly lower level of depression.	The proportion of participants meeting the MVPA guidelines was 48.5%.	The proportion of participants meeting SB guidelines was 68.9%.	Meeting SB and MVPA guidelines were associated with a significantly lower level of depression
Lin et al, 2020. [80]	China Institution	College students, aged (20.17±1.87)	Most of the participants reported a lower level of PA, which was associated with an increase in the risk of developing depression	- 58.6% of participants were in a low activity level - 32.16% of the participants were in the moderate activity level - 9.28% participants were included in the high activity level	N/A	- Low activity level was associated with depression - Moderate-intensity PA MET-mins/week was significantly associated with A lower risk of depression
Liu et al, 2021. [81]	China Health Care	COVID-19 Patients, aged 20-80 (mean 50)	QARP may help improve lung function and symptoms such as shortness of breath and cough and reduce the length of hospital stay among patients with severe COVID-19	N/A	N/A	QARP group showed a significant improvement in all vital signs (except blood pressure) and clinical scales, and improvement in mMRC dyspnea scale and the modified Borg dyspnea scale
Ma et al, 2020. [82]	China Community	Adults with/ without chronic disease, aged 18-80 (31.8±9.9)	Greater mental distress was significantly associated with both an increase and decrease in PA during the pandemic; however, the majority of the participants reported an increase in PA	- 57.5% reported increased PA "a lot" or "a little" - 26.2% decreased "a lot" or "a little"	N/A	An increase or decrease in PA was associated with mental distress

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Ma et al, 2021. [83]	China Community	General adult population, aged 18-80 (31.05±9.86)	It was found that half of the participants (52.14%) have active physical exercise in various places (home, gym, and sports centers), and they have appropriate behaviour coping correlated positively with physical exercise.	- 53.15% of the participants had exercised at home - 46.38% of the participants had exercised frequency of 1-2 times/week, 29.22% exercised frequency of 3-4 times a week, and 24.39% exercised frequency of > 5 times a week. - The mean value of exercise behaviour of the participants was 3.25±6 2.41 points	N/A	N/A
Maatouk et al, 2021. [84]	Lebanon Community	General adult population, aged 18-86 (28.55±12.198)	More than half of the participants were engaged in physical activity during the COVID-19 pandemic.	- 45.8% did not perform PA during the pandemic - 37.5% reported performing PA 2 to 3 times/week - 16.8% reported performing > 3 times/week	N/A	Higher anxiety scores appeared in women with less sports
Madan et al, 2021. [85]	India Community	General adult population, aged 18-50	During the COVID-19, most of the participants were physically active, and the most common physical regimens were yoga (58%), walking/running (56%), breathing exercises (52%)	66% reported no change in PA and 21% reported an increase in PA - 44.9% reported being physically active for 30 mins to 3 hours 13% reported a decrease as they perform <30 min	N/A	N/A
Magliah et al, 2021. [86]	Saudi Arabia Health Care	T1DM patients, aged >18 (30±7.88)	Most of the patient's PA decreased, and it was found it affected body weight and glycemia	-67.7% of patients decreased PA -23.1% of the patient increased PA - 9.2% remained unchanged in PA	N/A	An increase in PA levels was more likely to report weight loss and a decrease in experiencing hyperglycemia and vice versa
Makizako et al, 2021. [87]	Japan Community	General adult population, aged >20 (44.6±13.7)	Regular exercise during the COVID-19 pandemic was linked with lower rates of poor SRH and poor sleep quality among middle-aged adults in Japan.	27.7% had a regular moderate exercise of >30 min/day > times/week over a continuous period of one year or longer habit during the pandemic	N/A	- Regular exercise was significantly associated with lower-rate of poor SRH - Regular exercise was significantly associated with a lower rate of poor sleep quality among middle-aged adults
Makizako et al, 2021. [88]	Japan Community	General adult population, aged 40-69 (50.1±6.9)	Participants who perceived declining in physical fitness during the COVID-19 state of emergency showed a >50% decrease in PA time in April 2020 and remained reducing to a lesser degree in October 2020	- 32.4% decrease in PA time per week in April 2020 - 15.5% decrease in PA time in October 2020 - 33.8% decline in physical fitness	N/A	N/A
Minsky et al, 2021. [89]	Israel Health Care	Overweight/obese patients, aged (53±13)	Respondents who obtained virtual obesity treatment were more likely to increase their weekly exercise and weight loss during the lockdown.	Exercise increased during lookdown	N/A	55% reported weight loss when exercising more
Mohamed et al, 2021. [90]	Turkey Health Care	COVID-19 Patients, aged 20-80 (mean 50) years	Two weeks of moderate-intensity aerobic exercise decreased the severity and progression of COVID-19 associated disorders and quality of life.	N/A	N/A	After two weeks of intervention, the Wisconsin scale (patient-oriented illness-specific quality-of-life) total score significantly decreased in the intervention group; while Leucocytes, Lymphocytes, and Immunoglobulin significantly increased in the intervention group compared to the control group

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Muna Abed Alah, 2021. [91]	Qatar Community	Adults with/ without chronic disease, aged 18 - >60	Average time spent in exercise decreased while sitting/reclining time, screen time increased, which resulted in increased body weight	A significant reduction in the average time spent in exercise by 6.6 min/day	A significant increase in sitting/ reclining time (1.94 h/day mean), screen time (2.05 h/day mean)	Reduction in exercise time and increase in sitting/ screen times were significantly associated with increased weight gain
Nagata et al, 2021. [92]	Japan Community	General adult population, aged 20-69	Physical inactivity had increased during the pandemic, and SB increased, resulting in strong anxiety related to the pandemic.	More than 20% reduction in steps count	More than 60% spent time in SB	A decrease in walking behaviour and increase in SB were correlated with strong anxiety
Narkprasit, 2021. [93]	Thailand Community	Retired officers and employee, aged (Mean 59.2)	The active exercise group had an overall better health record with fewer chronic diseases than the low exercise group during the COVID-19 pandemic	The active exercise group was more active with the top three activities indicated were walking at 64%, running at 24 %, and dancing at 21% compared with the low active group the top activities which were walking at 77 %, cycling at 14 %, and housework at 14 % respectively.	N/A	- 43% Active exercise group (AEG) had better body figures and health without diseases compared to the lower exercise group (LEG) 39% - AEG had a lower percentage of chronic diseases compared to LEG - AEG had better physical health 86%, better mental health 64%, and disease prevention 52%
Nguyen et al, 2021. [94]	Vietnam Health Care	Outpatient, aged 18-85 (42.8±16.7)	COVID-19 lookdown was associated with a lower likelihood of having unchanged or more PA	- 36.8% less active - 27.3% unhanged PA - 14.9% more active	N/A	N/A
Nguyen et al, 2021. [95]	Vietnam Health Care	Outpatients with/ without diseases, aged 18-85 (Mean 44.4)	Most of the outpatients were physically active and were associated with lower COVID-19-like symptoms	- 71.9% physically active - 28.1% physically inactive	N/A	People with high PA had lower COVID-19-like Symptoms
Nishijima et al, 2021. [96]	Japan Community	General adult population, aged >20	The extension of at-home hours was negatively associated with a decrease in PA and an increase in SB	- 50% decrease in total PA during the stay-at-home request period - 30% decrease in total PA after the stay-at-home request period	44.7% increase in sedentary activity among extended at-home hours during the stay-at-home request period	N/A
Nuray Girgin et al, 2021. [97]	Turkey Community	General adult population, aged 15 to 65	Participants had minimal activity levels and an increase in sitting time	- The total physical activity MET score for females was 835.50±1068, and 1072.4±1447.68 for males.	Sitting time/day was 2.49±6.05 hr for females and 3.44±3.76 hr for males	N/A
Obuchi et al, 2021. [98]	Japan Community	General adult population, 20-80 (60.3±28.9)	It was found that there is a marked decrease in the average number of steps taken per week in outdoor walking by approximately 23% during the state of emergency, indicating that individuals' activity levels have been affected	The number of steps at nine weeks or later decreased by (approximately 3400 steps) in 2020 compared to that in 2019 (approximately 4400 steps)	N/A	N/A
Pal et al, 2021. [99]	India Community	T1DM patients, aged 18-30	As reported by the participants, the apparent worsening of blood glucose could have resulted from a reduction in physical activity.	- 90% reported a decrease in PA/exercise during the lockdown 57% had resorted to some form of PA like walking	N/A	Higher blood glucose was more likely due to the decrease in PA
Park et al, 2021. [100]	Korea Institution	General adult population, aged >18 (23.7±6.0)	-PA decreased as the level of social distancing increased - The daily step counts in urban and suburban also tended to decrease as the social distancing increased	Daily steps counts were reduced from 6747.09 to 5812.11 during the COVID-19	N/A	N/A

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Qi et al, 2020. [101]	China Community	General adult population, aged >18 (31.8±8.6)	The COVID-19 pandemic had decreased PA and increased sedentary sitting time among the participants	- 64.8% engaged in low amounts of PA (<600 MET -min/week) - 18.0% engaged in moderate PA - 17.2% engaged in high levels of PA	- SB increased from (5.4±2.9) pre-lockdown to (5.8±4.6) during the pandemic	High PA was associated with higher levels of HRQoL and lower levels of perceived stress, while high sedentary time was associated with lower HRQoL
Qin et al, 2020. [102]	China Community	General adult population, aged 18-80	Most of the participants adopted a sedentary lifestyle with insufficient PA and more screen time.	Physical activity level declined vigorous (226.7 ± 163.4 min) vs moderate (251.4±178.4 min) vs light (277.7±200.7 min).	- Screen time was > 4 h (261.3±189.8 min) among participants during the quarantine - High screen time (305.6±217.5 min) was among young adults aged 20-24 years	Participants with vigorous PA have a better emotional state
Radwan et al, 2021. [103]	United Arab Emirates Community	General adult population, aged 18 ->40	Among the unhealthy lifestyle changes examined, PA decreased; however, most of the participants reported their PA was the same during the lockdown	- 53.5% reported no change in PA - 30.0% reported a decrease in PA - 16.5% reported an increase in PA	N/A	N/A
Rajoo et al, 2021. [104]	Malaysia Community	General adult population, aged 18-40 (26.2±4.14)	It was found the exercise program has the potential to be a form of medicine, specifically in mental health, during the COVID-19 pandemic	N/A	N/A	After the nature exercise, depression baseline reading had significantly reduced from (8.67±4.53) before the program to (7.2±7.2) after the program, stress level reduced from (11.27±4.41) to (13.13±3.96), and anxiety reduced from (6.8±3.63) to (5.27±3.6)
Rastogi et al, 2020. [105]	India Health Care	Diabetes patients, 52-64 (mean 58)	Most of the respondents engaged themselves in PA by doing household chores and indoor exercise consequent upon the availability of time that was reflected in a significant increase in GPAQ scores during the lockdown, and an increase in PA was associated with improvement in the glycemic parameters	- PA increased with GPAQ score of 140 (0.0 to 1260) METs to 840 (0.0 to 1680) METs	N/A	An increase in PA resulted in an overall improvement in glycemic parameters with a significant reduction in HbA1c and postprandial blood glucose
Rogowska et al, 2021. [106]	International (Slovenia, Czech Republic, Germany, Poland, Ukraine, Russia, Turkey, Israel, and Colombia) Institution	College/ university student, aged 18-60	It was found that university students in Turkey and Israel had insufficient levels of PA	- An insufficient level of PA (PA < 150 min per week) was reported by 61.86% of university students, most frequently in Turkey (85.48%) - 62.31% of the participants in Israel reported their PA is insufficient	N/A	N/A
ag6t et al, 2020. [107]	Saudi Arabia Community	General adult population, aged 18-64	COVID-19 has resulted in significant changes in lifestyle, including a decrease in PA and an increase in time spent sitting, and due to these changes, the incidence of LBP increased	- Moving always or most of the time decreased by 15.2% - Participants practicing three, six, or seven-times PA significantly decreased by 21.6% - Subjects who did not practice PA and practiced only once a week significantly increased by 17.6%	Sitting all or most of the time during the quarantine significantly increased to 50.9%	Participants who spent time sitting and did not practice PA were found to be presented with higher lower back pain than those who practiced once a week, two or three times a week, four or five times a week, and six or seven times a week

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Salman et al, 2021. [108]	Kuwait Community	General adult population, aged >21 (37.7±11.6)	The COVID-19 pandemic has resulted in significant changes in PA behaviour, with a majority of the participants reporting a decrease in PA	- 33.1% reported performing <30min of PA or exercise in a week - 13.8% reported performing 30 mins or more of PA in 3 days	N/A	PA was positively associated with the quality of sleep
Samejo et al, 2021. [109]	Pakistan Community	General adult population, aged 18-25	The study results suggested that the levels of PA among young adults have decreased during the pandemic	- 81.8% engaged themselves < 1 hour in riding a bicycle or walking to and from work - 57.8% engaged themselves for < 1 h/week in light physical activities like walking, cleaning, raking the lawn, or yoga - 77.9% of the participants engaged themselves for less than one h/week in moderately strenuous activities - 74.5% engaged < 1 h/week in strenuous sports and conditioning exercises	- (43.2%) used to sit and watch TV quietly or listen to music for 1-3 hours in leisure time - (6.5%) sat and watched TV quietly or listened to music for 6-8 hours in their leisure time.	N/A
Sankar et al, 2020. [110]	India Health Care	T2D patients, aged >50 (58.67±10.8)	Most of the participant's PA had not changed during the lockdown, and those who were less physically active had poor glycemic control	- 80% of the participants reported no significant change in their PA pattern - 31.3% of those between 50 and 65 years and 56.3% of those less than 50 years of age, their PA has reduced	N/A	For those who were less physically active, their Delta A1c and HbA1c significantly increased during the lockdown
Sato et al, 2021. [111]	Japan Community	Health app (CALO mama) users, aged <20- 59	Participants' weekday steps had decreased during the declaration period, and a decrease in walking was positively associated with depressive symptoms	70% of the participants reduced their weekday steps during the declaration period	N/A	Decreased weekday steps and increased working hours were positively associated with depression symptoms
Shaun et al, 2021. [112]	Bangladesh Institution	Undergraduate Students, aged 18-33	PA has decreased, and screen time has increased during the lockdown	Almost 26% of participants did household activities during the lockdown, which lowered to 19.04% when the restriction was withdrawn. - 29.44% of students reported they never contributed to home activities after lockdown, which is much higher than the time of lockdown of a rate of 19.04%	During lockdown - (30%) spent screen time for study or work for 1-2h/day, and (26.4%) spent >5h/day - (44.7%) spent screen time for entertainment for >5h/day, and (28.7%) for 3-5 h/day	(51.6%) participants who performed three h exercise/week have maintained their weight (33.2%) gained weight due to not training after the lockdown
Sooriyaarachchi et al, 2021. [113]	Sri Lanka Community	General adult population, aged 16->40 (32.95±9.82)	Most of the participants reported a decrease in daily exercise and SB, such as sitting time, screen during the COVID-19 pandemic period	52.4% reported a reduction in daily exercise	- 63.5% reported an increase in sitting time - 80% reported an increase in screen time on television, cell phones, and laptops	N/A
Srivastav et al, 2021. [114]	India Institution	Undergraduate, Interns, postgraduate, and doctorate students aged 23.9	About 48% of PA and 49% of energy expenditure were decreased in physiotherapy professionals and students during the lockdown period compared pre lockdown period.	- PA decreased by (-48%) with a (413 MET-min/week) - VPA decreased by (-57.3%) during the lockdown - MPA decreased by (-63.5%) during the lockdown period with a (728.2 MET-min/week) - Walking decreased by (-27.4%) with (2242.3 MET-min/week)	Sitting time increased from 332.9 MET-min/week) before lockdown to (1255.3 MET-min/week) during the lockdown	N/A

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Suka et al, 2021. [115]	Japan Community	General adult population, aged 25 to 64	SB and screen time has increased during the pandemic in both genders while MPA decreased, and the majority of the participants rarely or never engaged in VPA	- 46.1% males and 40.2% females have spent on MPA for 1-3 h - 51.2% males (53.2%) Females have never spent time on VPA	- 48.4% males and 52.2% females have spent time SB for 3 to 8 h - 27.3% males have spent time on tv viewing for 1-2 h while the female 20.5% has spent more time on tv viewing for >4 h	Decrease in PA and increase in SB were associated with deteriorating general health status
Tan et al, 2021. [116]	Malaysia and Indonesia Institution	Undergraduate students, aged 18-25	Most of the participants were more physically active in both countries during the lockdown and engaged in more than 8 h of SB	- 79.6% of Malaysians and 77.6% of Indonesians were physically active (>600 MET minutes/week) during the lockdown - Total PA during the COVID-19 pandemic, Malaysian students had a slightly higher (M = 2826.00 MET minutes/week) than Indonesian students (M = 1782.00 MET minutes/week).	Malaysian students (9.16±4.47 h/day) spent a significantly longer duration engaged in sedentary behavior compared to Indonesian students (7.85±4.27 h/day) during the home confinement	There was a weak association between the duration engaged in the VPA and weight change in Malaysia, while no significant correlation was observed between the period devoted to moderate-intensity activity, walking, total PA, or sedentary behavior and weight change.
Tan et al, 2021. [117]	Singapore Community	Pet/Non-Pet Owners with/ without chronic disease, aged 21-64	Pet owners have a higher mild-intensity PA level than non-pet owners during the pandemic	- Pet owners reported 31.8 more minutes of weekly mild-intensity PA compared to non-pet owners - moderate- and vigorous-intensity PA levels were similar across the two groups	N/A	N/A
Terai et al, 2021. [118]	Japan Health Care	Orthopedic patients, aged (52.5±21.9)	Almost half of the participants reported a decrease in their exercise habits during the pandemic thus this reduction was related to a decrease in HRQoL	45.2% reported a decrease in exercise habits, while 36.7% reported they had a stable exercise habit	N/A	Patients with decreased regular exercise habits had a more significant reduction in HRQoL compared with those with stable regular exercise habits
Tran et al, 2020. [119]	Vietnam Health Care	Healthcare workers, aged 21-60	Most of the participants had unchanged or more exercise during the pandemic; thus, PA was associated with a lower likelihood of anxiety and depression and higher HRQoL	61.6% reported unchanged or exercising more while 38.4% stopped or exercising less or never	N/A	Participants who never/ stopped/less of PA had a greater likelihood of anxiety and depression and lower HRQoL scores, while participants who had unchanged/more PA status had a 65% likelihood of lower anxiety, 46% lower depression, and 6.29 higher HRQoL score
Tran et al, 2021. [120]	Vietnam Institution	College students, N/A	It was found that PA decreased while SB increased during the pandemic	42.24% of the respondents answered that they exercised less - 12.16% of the respondents worked out more during the ongoing pandemic.	SB increased during the pandemic	N/A
Tsai et al, 2021. [121]	Taiwan Community	Adults with high mental risk, aged 13-45 (25.74±7.09)	The online health-promotion program showed significant improvements in PA levels in young adults during the pandemic	- The amount of moderate aerobic exercise was increased significantly from the mean pretest (5.39±146.20) to (210.12±337.56) post-test - Participants doing moderate aerobic exercise for > 150 min/week increased from 25.0% to 50%.	N/A	N/A
Ullah et al, 2021. [12]	Pakistan Institution	University students, (21.88±1.56)	During the COVID-19 pandemic, almost half of the participants were physically inactive and SB.	- 48.2% were physically inactive - 42.8% were moderately active - 9.1% were highly active	-45.2% reported were SB, while 54.8% reported were not SB during the pandemic	N/A

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Uysal, Argın, 2021. [123]	Turkey Community	Adults with/without COVID-19 or chronic disease, aged 18 - 90	Due to the pandemic, a decrease in regular PA and sports activities has been observed. Participants who tested negative for COVID-19 and with no chronic disease had a higher PA compared to those with positive test results	- 47.6% performed medium intensity PA in the form of speed walking or straight running at least five days a week/30 to 60 mins/day - 19.2% performed medium-high-intensity PA	N/A	N/A
Uz et al, 2021. [124]	Turkey Health Care	COVID-19 patients, aged > 18 (48.86±14.58)	The severity of COVID-19 disease was higher in patients with less PA and low functional capacity, while regular PA improves the functional capacity	- The pre-disease level of PA was significantly lower in patients with pneumonia (all patients: 2346.92 [621.08] in patients with pneumonia and 4556.77 [1308.61] in patients without pneumonia - The pre-disease level of PA was significantly lower in patients with oxygen requirement (all patients: 2171.0 [574.09] in patients with oxygen requirement and 3827.4 [1515.39] in patients without oxygen requirement	N/A	-Exercise training can increase the functional capacity of the patients and decrease the severity of COVID-19 disease - The severity of COVID-19 disease was higher among patients with less PA and low functional capacity
Verma et al, 2020. [125]	India Community	General adult population, >18 (28.70±8.90)	Most of the participants had engaged themselves in more in multiple forms of physical fitness activity like yoga and home-based exercise, while some participants had reported not performing any form of PA at all during the lockdown	- 39% reported engaging in home-based exercise, and 28.0% engaged in yoga-based activities - 32.0% reported they didn't do any PA during the lockdown	64.0% spent their time on social media, and 63.0% were watching television during the lockdown	Engaging in physical fitness activity was found to be beneficial in coping with stress and anxiety
Wang et al, 2020. [126]	China Community	General adult population, aged 40 (51.6±8.9)	The prevalence of low daily steps increased substantially after implementing physical distancing measures, from 2.0% to 25.5%	- Daily steps decreased during physical distance measures from 8624 to 4121 steps/day - >7% of residents had walked >1500 steps/day for >14 days - Mean daily steps dropped by 2678 steps	N/A	N/A
Wang et al, 2020. [127]	China Community	Adults with/without chronic disease, aged 18-80 (27.8±12)	Participants staying at home during the pandemic had led to a decrease in PA and an increase in SB	-52% reported a reduction in the level of PA - 66% reported having a light PA - 40% did not perform MPA (jogging, Tai Chi, and dancing) - 55% did not perform VMPA (rope jumping and weight training)	67% reported an increase in their sitting time (7.4±3.4) h/day, and 61% increased their time spent lying down (9.2±3.7) h/day	PA has a positive association with QoL while SB has a negative association with QoL
Wang et al, 2021. [128]	China Community	General adult population, aged 31-60	During the pandemic, the self-reported daytime activity levels significantly decreased.	- The PA was lower during the pandemic - participants' average PA level was <1,700 steps	N/A	PA was positively related to well-being
Wang et al, 2021. [129]	China Community	low and high-density neighborhoods adults, aged <18 - >65	The COVID-19 and the social distancing measures have negatively impacted PA levels	PA in the neighborhood significantly decreased during the pandemic in all participants	N/A	N/A
Xiang et al, 2020. [130]	China Institution	College students, (20.68±1.84)	Half of the participants had inadequate PA during the pandemic, and it was found that stretching and resistance training alone was significantly associated with low anxiety, while household chore, stretching, and resistance training resulted in a reduction in depression	- 52.3% had inadequate PA - The mean (SD) time spent on VPA was (90.09±78.53), MPA (133.34±79.70), and walking (157.4±95.31) min/week	N/A	Participants with a high level of PA were significantly associated with low anxiety, while a moderate or high level of PA was significantly associated with a decrease in depression

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Yilmaz, 2021. [131]	Turkey Institution	Adults with/ without disease, aged 18-65	During the pandemic, it was found that PA levels decreased, and most of the day was spent sitting and lying down	Daily physical activity durations were determined as (8·25±1·77)	(4.21±2.68) h for works performed lying down, (5.42±2.64) h for works performed sitting	N/A
Yan et al, 2020. [132]	China Community	Adults with/ without diabetes, aged 18-80 years	PA had increased among diabetic patients compared to non-diabetics, and those who increased their PA have an excellent/ good health	- 44.6% increased PA among diabetic participants compared to non-diabetic (16%) -73.8% diabetics have a higher proportion of meeting the weekly 150 min PA recommendations compared to non-diabetics (58.1%) - The prevalence of daily exercise was 12.9% among diabetes while 8.2% without diabetes	N/A	Participants who increased their PA or performed 150min/week PA was positively associated with excellent/very good health
Yang et al, 2020. [133]	China Institution	High School, Undergraduate, and Graduate Students, aged (19.8±2.3)	The activity patterns have significantly changed, including the decreased frequency of engaging in active transport, moderate/vigorous-intensity housework, leisure-time moderate/vigorous-intensity PA, and leisure-time walking, and the increased sedentary, and screen time	- 50.2% for moderate/vigorous-intensity housework (MVH) and 78.5% for MVPA maintained their activity levels - 37.0% for MVH and 18.0% decreased in PA	- 57% had maintained their screen time - 36% increased their time spent on screen - 42% had increased their sedentary time during both workdays and weekends	N/A
Yang et al, 2021. [134]	China Community	Adults with/ without chronic disease, aged 18 to >60 (37.3±12.0)	More than half of the participants reported a decrease in PA during the COVID-19 lockdown.	- 54.3% reported a decrease in PA - The total weekly time spent in PA was 105.0 (22.5-281.3) min -The amount of time spent performing PA per week was 45.0(3.8-157.5) mins for low PA, 3.8 (3.8-45.0) mins for moderate, and 3.8 (3.8-3.8) mins for vigorous intensity	N/A	N/A
Yeoh et al, 2021. [135]	Singapore Health Care	Diabetes patients, aged 21- >60	PA involvement was the most negatively affected, with 38% of respondents less frequently able to keep physically active.	- 40% reported being able to keep the same level of PA - 22% reported they were more frequently able to keep themselves physically active - 38% reported they were less physically active	N/A	N/A
Yoshimoto et al, 2021. [136]	Japan Community	Workers, aged 20-64	Decrease in PA was high among workers with pain augmentation than in those without pain augmentation, and a reduction in PA was associated with high pain argumentation	47.2% reported a decrease in PA	N/A	A decrease in PA was associated with an increase in pain argumentation
Zach et al, 2021. [137]	Israel Community	General adult population, aged 18-90 (50.2±14.5)	The physically active participants during the lockdown period reported a higher level of resilience and positive feelings and a lower level of depression than those who were not physically active.	- 25% stopped PA during the lockdown - 39% started PA during the lockdown	N/A	- Participants who were physically active during the lockdown had a lower BMI and depression, while those who were inactive during the lockdown were on average overweight and had a higher BMI and depression
Zhang et al, 2020. [138]	China Community	Workers, mean aged (36.6±10.5)	PA had decreased during the pandemic	- 61.2% exercised but for less than one h/day - 17.1% exercised 1-2.5 h/day - 13.8% had not exercised at all during the past week	N/A	N/A

Table II: Summary of the included studies (n=132) (continued)

Study, Year	Country, Setting	Population characteristic, Age (Range or Mean ± SD) Years	Main Findings	Changes in Physical Activity (Scores, Levels, etc.)	Changes in Sedentary Behaviour (Scores, Levels, etc.)	Health Outcomes
Zhang et al, 2020. [139]	China Institution	College students, aged (20.70±2.11)	The amount of PA was significantly higher in male participants than in female	- Participants exerted 354.55 METs (SD=613.41) of vigorous physical activity every week on average - 43.9% reported MPA while 28.7% reported low PA	Total minutes spent weekly on SB were (2881.06 (1086.27))	PA has significantly reduced depression, and 108 min of light, 80 min of moderate, or 45 min of vigorous PA every day appeared to reduce negative emotions
Zhang et al, 2021. [140]	China Institution	University Students, aged (20.51± 1.88)	PA has decreased during the pandemic, and time spent on screening has increased. Screen time for 1 to >4 h/day and performing PA for less than three days/week was associated with depression symptoms	70.7% of the participants performed PA for < 3 days/week, and 29.3% performed PA for 3 days/week	47.3% of the students have screen time of > 4 hours/day.	- A higher rate of depressive symptoms was found in students who reported higher screen time - A higher rate of depressive symptoms was found in students who reported lower physical activity
Zhao Hu et al, 2020. [141]	China Community	General adult population, aged 18-60	The majority of the participants reported were more active in leisure-time physical exercise and spending more time looking at the screen	- 58.8% of the participants had the leisure-time physical exercise of more than 150min/week. - 17.0% of the respondents stated that they spent more time doing physical exercise.	- 86.8% had screen time of 2 hours/day or more.	Low PA was associated with a higher risk of lower subjective well-being
Zheng et al, 2020. [142]	China Community	General adult population, aged 18-35 (21.1±2.9)	PA behaviour significantly decreased in all types (MPA, VPA and walking) while time spent SB increased during the COVID-19 pandemic	- 70% reported their PA decreased since the COVID-19 started with an average of 3 min/day spent in MPA and 17 min/day walking - 57.8% didn't engage in any VPA during the pandemic	- Daily SB was (9.4±3.0 h/day) - Time spent SB increased from (7.8±3.2) before the pandemic to (10.0±3.2) during the pandemic	N/A
Zhou et al, 2021. [143]	China Institution	Primary, middle, high school and college teachers, aged 20-65	PA has decreased during the pandemic, and it has been found that less physical exercise was associated with a higher incidence of depression	- 64.1% vs 48.7% had a physical exercise duration/day of <30 min	N/A	Low PA <30 min/day was one of the factors associated with suffering from depression
Zhou et al, 2021. [144]	China Institution	High school, junior college, undergraduate, postgraduate students, aged 15-33	COVID-19 had impacted participants' PA, and SB as more participants reported a reduction in PA level than those indicated increased, and more participating had their SB level increased than those who had it decreased	38.6% pre-lockdown reported performing >150 min/weeks then it drops to 19.4% during the lockdown then increased to 25.3% after the lockdown	The means of hours/day spent in SB had significantly increased during lockdown compared to pre-COVID-19 as the average time spent in sedentary behaviors on a workday in women was 4.3 h, then increased to 5.1 h	N/A
Zhu et al, 2021. [145]	China Community	General adult population, aged 16-70 (31.8±11.4)	Due to the "stay at home," there was a significant decrease in PA, especially outdoor exercise, and a slight increase in SB during the COVID-19 pandemic	- 54.9% reported a decrease in PA, especially in outdoor activities - 44.9% reported not performing at all strenuous PA, while 26% reported doing strenuous PA one day/week - 24.3% reported not performing MPA, while 19.6% reported performing MPA two times/week - 27.1% did not go for walking while 19.3% go for walking two times/day - Number of steps/day has decreased from 6427± 4374 to 2714± 3542 steps/day	SB has increased from 5.3±2.7 to 6.6±3.1 hrs/day	A decrease in PA was associated with weight gain, and normal-weight people were more likely to gain weight than overweight and obese

Table III: Physical activity and sedentary behaviour measurements used in the included studies (n=132)

Types of Measurements	Measurements	Number of articles
Questionnaires and Self-Reported Measurements	Online Questionnaire (name not specified)	70
	International Physical Activity Questionnaire-Short Form (IPAQ-SF)	30
	Global Physical Activity Questionnaire (GPAQ)	7
	International Physical Activity Questionnaire (IPAQ)	6
	International Physical Activity Questionnaire-Long Form (IPAQ-LF)	5
	Japanese 6-items Questionnaire with a 1-week recall period	2
	Pregnancy Physical Activity Questionnaire (PPAQ-J)	2
	Physical Activity Questionnaire (PAQ)	1
	Physical Activity Vital Signs	1
	Physical Activity Checklist (3MPAC)	1
	Work-related Physical Activity Questionnaire (WPAQ)	1
	Sedentary Behaviour Questionnaire (SBQ)	1
	Chinese National Student Physical Fitness Standard (CNSPFS)	1
	Public Health Center Physical Activity Questionnaire Short Form	1
	17-Point Scale From "0" to "16	1
	The five-item scale to assess sport	1
	Membership in sports clubs	1
Objective Measurements/Tools	Accelerometer	3
	GPA Signal	2
	Pedometer	2
	iPhone Health App	2
	WeRun Application	1
	Wearable Fitness Tracker	1
	Actigraph Accelerometer (wGT3X-BT)	1
PA Programmes	Exercise Programme	2
	Qigong Exercise and Acupressure Rehabilitation Programme (QARP)	1
	Virtual Physical Exercise-Modified Instrument	1
	6-minute walking test	1

mean. Screen time was often broken down by mobile device, computer, television, or media usage, including social media and entertainment for work-related time, online study, or leisure time.

The increase in SB was documented in all studies; of these 12 studies have found time spent on screen, sitting, and sedentary was from 4 to more than five hours per day, while ten studies reported more than 6 hours per day during the COVID-19 pandemic. College and university students (12%) had additional screen-time (69,80,83,132,153,160), followed by (8%) spent their time sedentary (136,140,142,164) and only one study reported time spent sitting (134). Three studies have found that during the pandemic, workers tend to spend more time sitting (36,91,92).

DISCUSSION

In this scoping review, we identified and examined the extent of the changes in PA and SB in adults in Asia, after the COVID-19 pandemic was declared by the WHO. These changes were linked to numerous mental and physical health outcomes such as mental distress, depression, mood and emotional state, happiness, quality of sleep, body weight changes, quality of life, pain, glycemic and HbA1c, immunity, as well as health outcomes of COVID-19 patients.

Changes in PA and SB and the Associated Health Outcomes

Mental Health, Psychological Distress, Mood and Emotional State, Happiness, and Quality of Sleep

Mental health was reported in seven studies; of these, five studies have found that PA has a positive impact on mental health where participants who exercise regularly or their PA levels have increased during the pandemic tend to have better mental health (66,44,47,82,93). Two studies reported participants whose PA decreased had increased mental distress (48,82). Specifically, greater PA or high moderate PA during the pandemic were found to be related with decrease in depression (23,28,41,45,69,73,79,80,104,119,130,137,139), stress (101,104,125) anxiety (28,119,130,104,125), psychological distress (25), and also improved mood status (31). Moreover, adults who performed VPA during the pandemic tend to have better emotional states (102), and for college students who spent 108mins of LPA, 80 mins of MPA, or 45 mins of VPA daily have decreased negative emotions (139). In addition, PA was positively related to the quality of sleep (87,108) and happiness (29).

Furthermore, the decrease of PA and increase in SB was related with the increase in depression (23,45,61,73,78,80,111,119,137,140,143), anxiety (45,54,84,92,119) and stress (60). Besides, a cross-sectional study in Turkey found significant but very small negative association between differences in PA scores and perceived stress (70). Interestingly, one study among general adult population (27) and one among postmenopausal women (68) has found that increased PA and decreased physical inactivity have resulted in an increase in anxiety.

Body Weight, HRQoL, QoL, Physical, Social and Self-related Health, General Health, and Well Being

After the COVID-19 outbreak, participants who had a higher PA or regular exercise were related with better

health outcomes such as weight loss (62,86,89,137), weight maintenance (40,112), and one study reported its a protective factor against weight gain (22), higher health-related quality of life (HRQOL) (25,101,118,119), better physical and social health (20,93), lower poor self-related health (SRH) (97) and improved general health (65,162). Moreover, two cross-sectional studies have found that PA was positively related to quality of life (QOL) (127) and well-being (128).

On the other hand, participants whose PA decreased during the pandemic has resulted in poor health outcome such as increase in body weight (15,22,23,30,40,62,86, 91,112,137,145), decrease in HRQOL (25,35,118,119), poor physical and social health condition (20), higher risk of lower subjective well-being (141), and decrease in general health status (115). Moreover, higher SB was also related to an increase in body weight (44,41,91), and a decrease in HRQOL (101) and general health status (72,115). One cross-sectional study has found that increased SB was negatively associated with QoL (135).

Health Outcomes of COVID-19 Patients, Chronic Disease, Glycemic, HbA1c, Pain, Immunity, Heart Failure Patients, and Eye Health

Higher intensity PA such as MPA/VPA/regular sports during the COVID-19 pandemic was related with decrease of COVID-19-like symptoms, infection, and mortality (32,50,58,75,95,81,124), lower percentage of chronic disease (93), improvements in glycemic (39,86,105), decrease in HbA1c among diabetes patients (105), and increase in the immunity among COVID-19 patients (90). One retrospective study reported no significant health change in heart failure patients with decreased PA (17).

Meanwhile, the reduction in PA was reported to be linked to the increase in the COVID-19 severity and mortality (21,58,124), a higher percentage of chronic disease (93), worsened glycemic (39,86), an increase in HbA1c (110), and an increase in pain augmentation among workers (136). In addition, an increase in SB was also related to an increased risk of illness among individuals with COVID-19 (58). An increase in screen-time was correlated with dry eyes among students attending college during the pandemic (69).

Gaps in the literature

Based on the findings from studies abridged above, where and what the evidence has or has not gathered should also be considered. Overall, studies more frequently used subjective or self-reported measurements of PA, especially online questionnaire, than objective measurements of PA. The levels and extent of lockdowns were not clearly stated in most studies. There was also a notable lack of intervention or experimental studies to prove causality.

Strengths and limitations

This review, to our knowledge, is one of the first scoping reviews that included studies that assessed changes in PA and SB during the COVID-19 pandemic, as well as the associated health outcomes across countries in Asia. An up-to-date and validated protocol and comprehensive search strategy was applied, which enabled a large number of relevant studies to be identified. In addition, the reporting of the results was conducted in concordance with the framework of the PRISMA-ScR guidelines.

A number of limitations exist. Due to COVID-19 precautions, most of the studies have utilised online questionnaires to assess PA and SB. The numerous measures of health outcomes were not clearly defined or standardised for comparison within the same outcome. In accordance with the guidelines of a scoping review, we did not appraise the quality of the studies and evidence included, and the purpose was to identify the nature of the research being undertaken and to present a descriptive account of available research.

CONCLUSION

This scoping review aimed to determine the available evidence on the changes in both PA and SB and its association with health outcomes after the COVID-19 pandemic was declared by the WHO. We present a synthesis of the breadth and outcomes of studies from across Asia, with substantial volume of evidence highlighting that PA levels had decreased, and SB increased due to social distancing measures. The bulk of the evidence also showed that increased PA had improved mental health outcomes. We found gaps in studies reporting subjective or self-reported measurements of PA and SB and a lack of intervention or experimental studies to prove causality. Further studies or summary papers on different populations are needed to enable the development of new policies, recommendations, or guidelines for the benefit of the community in similar situations.

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