

# Influence of Covid-19 lockdown on physical activity in three groups viz sedentary individuals, gym goers and athletes of age group 21 to 29years.

<sup>1</sup>Shreya Raval, <sup>2</sup>Romaisa Khan

<sup>1</sup>Msc in Sports Nutrition, College of Home Science Nirmala Niketan, Mumbai

<sup>2</sup>Professor, Faculty in Sports Nutrition, College of Home Science Nirmala Niketan, Mumbai

**Abstract-** Coronavirus disease (COVID-19), originated from Wuhan of China was declared as a global pandemic by World Health Organization (WHO) on 11th March 2020. Since, then it has spread all over the world affecting the life of millions of people. In order to bring down increasing number of cases, many countries including India implemented lockdown of citizens. In India, the lockdown was implemented in various states and cities which started in March 2020. This lockdown resulted in people being confined within their homes, and disrupted their regular daily activities. The current paper aims to find changes in physical activity due to lockdown in three groups viz sedentary individuals, gym goers and athlete group. This is a cross-sectional web-based study, where questionnaire made on google form was used for data collection. There were 90 participants in this study, with 30 in each group within age group of 21-29years both male and female. Participants with chronic disorder and athletes playing other sports except team sports or two sports at a time were excluded. This study reported an increase in sedentary behavior in all the groups and decrease in frequency, intensity and duration of physical activity in sedentary individuals and athletes. In conclusion, lockdown affected physical activity of all the groups, but the impact was more significant on gym-goers compared to sedentary and athlete group.

**Key words:** Covid-19 lockdown, physical activity, sedentary individuals, gym goers, athletes

## I. INTRODUCTION:

Coronavirus disease (COVID-19), originated from Wuhan of China was declared as a global pandemic by World Health Organization (WHO) on 11th March 2020. Since, then it has spread all over the world affecting the life of millions of people. In order to bring down increasing number of cases, many countries including India implemented lockdown of citizens. In India, the lockdown was implemented in various phases starting in March 2020, until the unlock phase which began in June 2020. This lockdown resulted in people being confined within their homes, and disrupted their regular daily activities and schedules including work, studies, exercise schedules and other leisure activities. Additionally, the COVID-19 pandemic and lockdown has resulted in people losing their lives or of their loved ones, people with medical conditions facing difficulty in receiving the due medical care, and has affected food availability and income for many. Thus, this lockdown has not only impacted the economy, medical and educational system of country, but has also impacted the life of people, either in a positive or negative way (Jena, 2020) (Sheth, 2020) (Gautam, 2020)

Lockdown has affected the physical activity, dietary habits and mental wellbeing of people. Due to lockdown migrants lost their job and were unable to have daily food availability for themselves and their family, due to this reason and due to zero travel facility they had to walk miles bare foot to reach their native place. Covid also took away many people life, due to this mental health of people was affected since they were scared and also depressed due to loss of their loved ones. Due to home confinement during lockdown, some people lost their habit of physical activity and healthy eating which resulted in weight gain. The common reasons for reduced physical activity and increased sedentary behavior are time unavailability, lack of motivation, and restricted access to parks, gyms, dance, or sports clubs (Chopra, et. al., 2020). Similar impact was seen on other group, in physically active individual people who did moderate intensity activity in pre lockdown started doing high intensity activity during and post (Hargreaves, et. al., 2021) while the highly active individuals dropped their intensity to moderate from pre to during lockdown and kept the same in post lockdown. (Castro, et.al.,2021). In athletes the physical activity was maintained but duration, intensity and frequency reduced in lockdown period due to online conduction of training (Da Silva, et. al., 2020). Study on elite African athletes found that the majority of athlete choose sedentary behavior over being active. (Pillay, et. al., 2020)

The effect of lockdown in India has been studied on sedentary individuals belonging to middle-age group (Chopra, et. al., 2020; Mehta, 2020) and on people with medical conditions such as diabetes, hypertension or mental disorder (Saqib, 2020). Till date, there are no studies done on young adults mainly college and office goers. Also, there are no research on impact of lockdown on physically active and athletes of India in terms of their lifestyle i.e., their training and dietary habits. Due to the lack of research on the effect of lockdown and its relaxation on the lifestyle of young healthy Indians, the present study aims to study the changes in physical activity due to lockdown of three groups viz sedentary individuals, gym goers and athlete group.

## II. Methodology:

This study was designed to assess the influence of covid-19 lockdown on physical activity in three groups viz sedentary individuals, gym goers and athlete group. In this study young adults (aged 21 to 29 years) were included.

### Selection of Participants:

The study was conducted on young adults including both male and female participants aged 21-29 years training at sports clubs, gyms or is sedentary. Grassroot level team sports athletes, college students and office goers involved in desk job were included in the study. Athletes playing more than one sport or playing other than team sports were excluded. Participants with health conditions like diabetes, hypertension or cardiovascular disease were also excluded.

The study comprised of 90 participants, (30 sedentary individuals, 30 gym-goers and 30 team sport athletes). Sedentary individuals either were involved occasionally in walking, yoga or home workout or were inactive pre-lockdown. Gym-goers group were those who were involved in daily gym activities pre-lockdown and athletic group were those who were grass root level athletes playing team sports like cricket, football and basketball. Individuals were contacted through social media platforms including WhatsApp and Instagram.

Prior to data collection, the participants were informed about the study in detail and the importance of their role in this study. Informed consent was obtained from all the participants.

A Questionnaire was specifically designed to collect data on physical activity pre-during and post lockdown. The Questionnaire was constructed on google forms and for the ease of filling, it was divided into two parts personal details and physical activity.

### Study Design

**Screening of Participants:** Individuals were approached from all over India through social media platforms like Instagram and WhatsApp, and were screened for eligibility for participation in the study.

**Selection of Participants:** After the participants are screened, they were selected according to the selection criteria for the study. Then they were divided into three groups based on their physical activity (like sedentary individuals -group 1, Gym goers -group 2 and grass root level team sports athletes- group 3).

**Collection of Data:** A Questionnaire that focuses on the physical activity levels pre, during and post lockdown, was used to collect relevant data from the selected participants. Questionnaire made on Google Form was shared with the participants.

**Analyzing and Evaluation of Results:** After the duly-filled questionnaire was collected, the data was analyzed and assessed to understand the influence of lockdown on physical activity levels and the challenges faced by the participants. The data was compared to the post lockdown period to understand whether relaxation of lockdown guidelines resulted in changes in their physical activity levels of the participants.

**Statistical Analysis:** The data was analyzed using the statistical package for social sciences (SPSS) software. The data was presented as mean  $\pm$  SD and percentages. Chi-square test was used compare the variables in all the three groups.

### III. Results and Discussion:

The purpose of the study was to understand the impact of COVID-19 lockdown on physical activity of sedentary individuals, gym goers and athletic group. The study was conducted on an online platform using a questionnaire.

#### Participants Characteristics:

The study comprised of 90 young adult participants (male and female), aged 21 to 29-year-old. All participants were based in Maharashtra, and were either sedentary (n=30), gym goers (n=30), or grassroot level athletes (n=30) participating in team sports such as cricket, football and basketball. Participant characteristics can be found in Table 3.1.

Table 3.1.: Characteristics of the Participants

Characteristics	Sedentary	Gym Goers	Grass Root Level Athletes
No of participants	30	30	30
Age (years)*	22.60 $\pm$ 1.94	22.83 $\pm$ 2.39	21.97 $\pm$ 1.47
Gender			
Males:	15	15	15
Females:	15	15	15
Occupation			
Student	21 (70%)	17 (56.7%)	23 (76.7%)
Working	9 (30%)	13 (43.3%)	7 (23.3%)
Anthropometric Measurements			
Height (cm)*	166.10 $\pm$ 10.16	165.63 $\pm$ 9.20	167.80 $\pm$ 7.74
Weight (kg)*	64.30 $\pm$ 11.33	65.63 $\pm$ 12.82	56.87 $\pm$ 7.44
BMI (kg/ m <sup>2</sup> )*	23.28 $\pm$ 3.46	23.87 $\pm$ 4.06	20.24 $\pm$ 2.65
BMI interpretation	Normal	Normal	Normal

\*mean  $\pm$ SD

Among all the participants, about 6.7% of sedentary individuals and 10% gym goers reported conditions such as abnormal period and vit d deficiency the rest did not have any medical condition. About 10% of gym goers reported use of medications like eltroxin and dietary supplements like calcirol, rinifol and tab hosit rest did not take any medication.

#### Physical Activity Levels of Participants Pre, During and Post Lockdown

For the purpose of the study, the participants were divided in three groups, viz. sedentary (n=30), gym-goers (n=30) and grassroot level athletes (n=30). The physical activity details of sedentary individuals, gym-goers and athletes pre, during and post-lockdown is summarized in Table 3.2.

Table 3.2: Physical Activity Levels of Participants Pre, During and Post Lockdown

	Sedentary			Gym Goers			Grass Root Level Athletes		
	Pre (%)	During (%)	Post (%)	Pre (%)	During (%)	Post (%)	Pre (%)	During (%)	Post (%)
<b>Physical Activity</b>									
Never	26.70	36.70	23.30	10.00	16.70	0.00	13.30	16.70	13.30
1-2times/ week	23.30	23.30	43.30	10.00	30.00	6.70	13.30	33.30	26.70

	Sedentary			Gym Goers			Grass Root Level Athletes		
	Pre (%)	During (%)	Post (%)	Pre (%)	During (%)	Post (%)	Pre (%)	During (%)	Post (%)
3-4times/ week	23.30	26.70	16.70	36.70	36.70	30.00	30.00	36.70	31.10
5-6times/ week	16.70	6.70	3.30	26.70	13.30	43.30	23.30	3.30	23.30
Daily	10.00	6.70	13.30	16.70	3.30	20.00	20.00	10.00	10.00
p value	0.406			0.010			0.311		
<b>Endurance Training</b>									
Never	30.00	26.70	16.70	16.70	26.70	0.00	30.00	50.00	36.70
1-2times/ week	30.00	33.30	36.70	30.00	40.00	36.70	26.70	23.00	26.70
3-4times/ week	13.30	26.70	20.00	30.00	16.70	20.00	30.00	16.70	26.70
5-6times/ week	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Daily	26.70	13.30	26.70	23.30	16.70	43.30	13.30	10.00	10.00
p value	0.634			0.035			0.809		
<b>Strength Training</b>									
Never	63.30	46.70	56.70	16.70	30.00	3.30	30.00	40.00	40.00
1-2times/ week	16.70	30.00	30.00	0.00	20.00	10.00	30.00	26.70	30.00
3-4times/ week	16.70	20.00	13.30	46.70	26.70	36.70	20.00	30.00	16.70
5-6times/ week	0.00	0.00	0.00	26.70	20.00	26.70	13.30	0.00	10.00
Daily	3.30	3.30	0.00	16.70	3.30	23.30	6.70	3.30	3.30
p value	0.737			0.013			0.655		
<b>Time of Exercise</b>									
Morning	56.70	76.70	63.30	46.70	43.30	66.70	40.00	40.00	50.00
Mid-Morning	0.00	0.00	0.00	13.30	6.70	0.00	3.30	10.00	3.30
Afternoon	6.70	3.30	6.70	16.70	20.00	3.30	10.00	16.70	10.00
Evening	23.30	13.30	20.00	16.70	30.00	30.00	46.70	33.30	33.30
Night	13.30	6.70	10.00	6.70	0.00	0.00	0.00	0.00	3.30
p value	0.829			0.049			0.738		
<b>Duration of Exercise</b>									
<30mins	50.00	60.00	53.30	13.30	33.30	17.80	23.30	20.00	20.00
30-60mins	46.70	33.30	40.00	33.30	40.00	34.40	40.00	46.70	43.30
60-90mins	3.30	6.70	3.30	46.70	23.30	53.30	23.30	20.00	20.00
>90mins	0.00	0.00	3.30	6.70	3.30	10.00	13.30	13.30	16.70
p value	0.750			0.071			0.999		
<b>Intensity</b>									
V. Easy	20.00	23.30	16.70	16.70	36.70	10.00	6.70	6.70	3.30
Easy	20.00	20.00	16.70	13.30	23.30	6.70	13.30	6.70	13.30
Moderate	46.70	36.70	53.30	36.70	26.70	43.30	50.00	63.30	53.30
Hard	3.30	16.70	3.30	23.30	6.70	30.00	20.00	10.00	16.70
V. Hard	0.00	0.00	0.00	10.00	6.70	37.50	3.30	3.30	6.70
Not Applicable	10.00	3.30	10.00	0.00	3.30	0.00	6.70	10.00	6.70
p value	0.527			0.080			0.977		
<b>Level of satisfaction</b>									
Excellent	26.70	33.30	30.00	63.30	26.70	63.30	40.00	40.00	36.70
Good	33.30	30.00	26.70	23.30	17.40	30.00	43.30	33.30	43.30
Average	23.30	20.00	26.70	10.00	23.30	3.30	10.00	10.00	6.70
Not Satisfied	3.30	10.00	3.30	0.00	16.70	3.30	0.00	6.70	6.70
Not Applicable	13.30	6.70	13.30	3.30	6.70	0.00	6.70	10.00	6.70
p value	0.926			0.008			0.944		
<b>Inactive hours</b>									
<4hrs	30.00	13.30	20.00	40.00	6.70	43.30	60.00	20.00	50.00
4-6hrs	30.00	26.70	26.70	26.70	20.00	26.70	20.00	26.70	26.70
6-8hrs	20.00	26.70	33.30	20.00	43.30	20.00	16.70	20.00	13.30
>8hrs	20.00	33.30	20.00	13.30	30.00	10.00	3.30	33.30	10.00

	Sedentary			Gym Goers			Grass Root Level Athletes		
	Pre (%)	During (%)	Post (%)	Pre (%)	During (%)	Post (%)	Pre (%)	During (%)	Post (%)
p value	0.605			0.010			0.012		

In the sedentary group, there was no significant difference with respect to frequency of physical activity pre, during and post lockdown ( $p=0.406$ ), but slight reduction was observed (refer fig 3.1). Similar results were observed by Chopra, et. al., (2020) and Trabelsi, et. al., (2021), wherein the physical activity of the sedentary individuals reduced and sedentary behavior increased. Contradicting results were observed from a Spain study, where the physical activity levels of the sedentary individuals increased during lockdown (Rodrigo, et. al., 2021) (Oscar, et. al., 2021). When the duration of exercise was assessed of the same group it was observed that participants doing physical activity for 30-60mins pre-lockdown, which reduced during lockdown but again slightly increased post lockdown (as shown in fig 3.2). However, the changes in the duration were statistically non-significant ( $p=0.750$ ). For those in sedentary group, involved in some physical activity, the intensity of the workout was found to be the same during all phases and not statistically significant ( $p=0.527$ ) and it was observed that participants found their workout harder during lockdown compared to pre and post lockdown. The participants in this group also reported not being satisfied with their physical activity levels during lockdown ( $p=0.926$ ). Moreover, sedentary behavior or sitting time in this group increased during lockdown and though it again decreased post lockdown (refer fig 3.5), it was not statistically significant ( $p=0.605$ ). Some individuals within this group were motivated to workout in lockdown (23.3%) while some were demotivated to work out (36.7%), ( $p=0.791$ ). For those who were motivated, the reported reason to be physically active were to stay fit (90%) followed by to feel good (86.7%) and to stay in good shape (73.3%). The self-reported reasons which motivated current study participants to stay physically active during lockdown were the additional time due to work from home /online classes situation and increased consciousness about health during lockdown. While the highest reported reason for not exercising/skipping workout was busy schedule (76.7%) followed by no time to work out (56.7%) and lastly unavailability of fitness center (56.7%). The self-reported reasons for not being active during lockdown were the restriction to parks and grounds which hampered participants walking, cycling activities and increased laziness due to home confinement. Similar reasons were also reported by Chopra, et. al., (2020) and Trabelsi, et. al., (2021). Majority of sedentary individuals in this study reported that their physical activity was best pre lockdown. More than half of the group believed that lockdown affected their physical activity, out of which half of the individuals believed that lockdown have negatively affected their physical fitness.

In the gym-goers group a statistically significant reduction in frequency in endurance ( $p=0.035$ ) and strength training ( $p=0.013$ ) as well as overall physical activity levels ( $p=0.010$ ) was observed during lockdown compared to pre lockdown, which again increased post lockdown (as shown in fig 3.1). Giustino, et. al., (2020) also reported similar results and found that reduction was more in male participants compared to female counterparts. However, this gender difference was not observed in the current study. Among the participants exercising for 60-90mins and >90mins in the pre-lockdown phase, it was observed that their duration of exercise reduced during lockdown, but not significantly ( $p=0.071$ ). Unlike the sedentary group, gym-goers found their activity very easy during lockdown (36.7%) compared to pre (16.7%) and post lockdown (10%) refer fig 3.2. Although the result was non-significant ( $p=0.080$ ). This group also reported a significant reduction in satisfaction levels post exercise ( $p=0.008$ ) and motivation level to exercise ( $p=0.00$ ) in the during-lockdown phase. They also reported an increased sitting time/leisure time due to lockdown ( $p=0.010$ ) refer fig 3.4 and 3.5. Majority of the gym-goers (56.7%) believed that their physical activity was best in the post lockdown phase, (83.3%) of gym-goers reported that lockdown affected their physical fitness, out of which 53.3% reported that lockdown affected their fitness negatively. All the gym-goers (100%) were motivated to exercise during lockdown in order to stay in good shape. The self-reported reasons which motivated them to be active during lockdown was their increasing weight and muscle atrophy, while the reasons which hampered their workout were closing of all the fitness centers and home environment which reduced their motivation compared to gym environment. Similar reasons were given by the physically active participants of Giustino, et. al., 2020 study.

In athletic group, a reduction in overall physical activity was observed (refer fig 3.1) but the reduction was not significant ( $p=0.311$ ) similar reduction in physical activity was observed in rugby players (Young, Mem et. al., 2022). When the duration of the exercise was assessed of the same group, the change in the duration was statistically non-significant ( $p=0.977$ ) hence, satisfaction levels of this group remained same during lockdown ( $p=0.944$ ) as shown in figure 3.2 and 3.4 respectively. Similar results were obtained in footballers' study where they were able to maintain their intensity and duration of training (Donmez, et. al., 2021). On contrary research done on badminton players observed that their duration for vigorous activity and moderate-high intensity activity reduced during lockdown (Da Silva, et. al., 2021). Moreover, sedentary behavior or sitting time in this group significantly increased during lockdown ( $p=0.012$ ) as shown in fig 3.5. Same as the African elite athletes of (Pillay, et. al., 2020) study were increase in sedentary behavior was seen. Some individuals of this group were motivated to workout in lockdown (53.3%) while some were demotivated (23.3%), ( $p=0.875$ ). Majority of the athletes (46.7%) believed that their physical fitness was best pre lockdown, (80%) of athletes believed that lockdown affected their physical fitness out of which (53.3%) of the athletes reported that the lockdown negatively affected their physical fitness. The self-reported reason which motivated athletes to be active during lockdown was the focus to improve their overall fitness. The reasons which demotivated athletes to train during lockdown were closing of academies, cancelation of events and competitions and home environment making them lazy and lethargic.

**Overall Physical Activity**

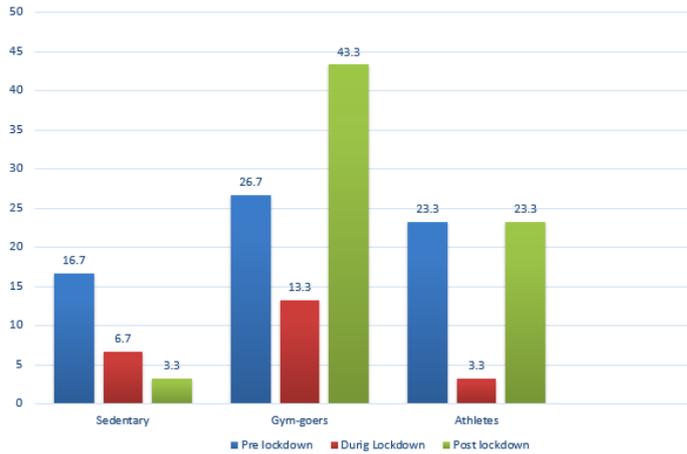


Figure 3.1

**Duration of Physical Activity**

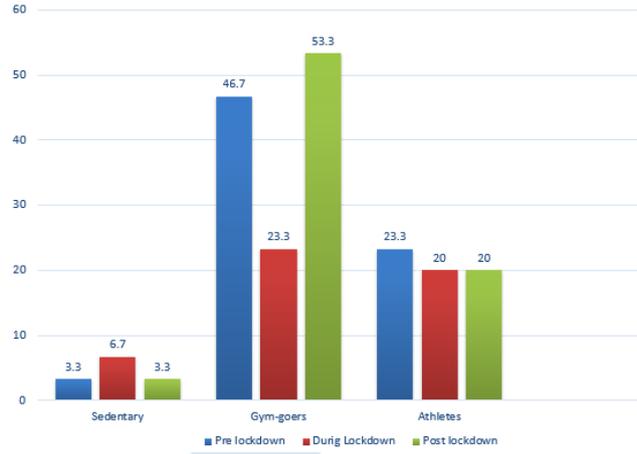


Figure 3.2

**Intensity of the Physical Activity**

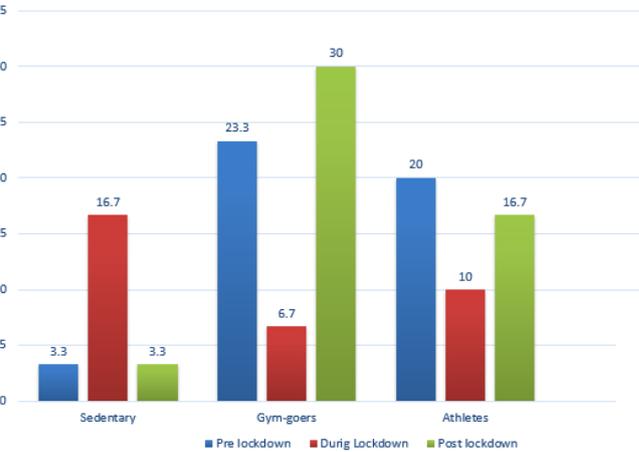


Figure 3.5

**Level of Satisfaction**

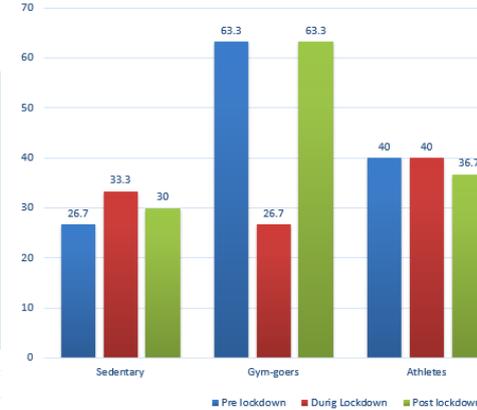


Figure 3.4

3.3

Figure

Sedentary

**Conclusion:**

In conclusion, a mixed response was observed in all three with regards to effect of lockdown on the physical activity levels. The frequency, intensity and duration of physical activity was not affected in sedentary and athlete group during lockdown, but in gym-goers physical activity reduced significantly. The sedentary behavior or sitting time also increased during lockdown in all groups. However, all the groups felt that their physical activity was best pre or post lockdown compared to during lockdown, and that the lockdown had negatively affected their physical activity, which they attributed to restriction to parks/grounds, fitness centers and sports academies, cancelation of events/competitions, reduced motivation and increased laziness due to home confinement.

**Acknowledgement:**

We would like to express our sincere gratitude to the college, College of Home Science Nirmala Niketan and the department of Food, Nutrition and Dietetics for providing such an amazing opportunity to learn and carry out research. We would also like to thank all the participants who removed time from their busy schedule and provided us with their personal data and valuable inputs for our study. Lastly, we would like to thank our friends and family who gave us moral support.

**References:**

1. Castro, B. M. De, Trindade, T. B., Augusto, P. V. S., Medeiros, M. A. De, Moraes, W. M. A. M. De, & Prestes, J. (2021). THE IMPACT OF QUARANTINE ON BODY IMAGE AND LIFESTYLE HABITS IN RESISTANCE TRAINING PRACTITIONERS. *Revista Brasileira de Medicina Do Esporte*, 27(1), 16–20. [https://doi.org/10.1590/1517-8692202127012020\\_0053](https://doi.org/10.1590/1517-8692202127012020_0053)
2. Chopra, S., Ranjan, P., Singh, V., Kumar, S., Arora, M., Hasan, M. S., Kasiraj, R., Suryansh, Kaur, D., Vikram, N. K., Malhotra, A., Kumari, A., Klanidhi, K. B., & Baitha, U. (2020). Impact of COVID-19 on lifestyle-related behaviours- a cross-sectional audit of responses from nine hundred and ninety-five participants from India. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 14(6), <https://doi.org/10.1016/J.DSX.2020.09.034>
3. Da Silva LF, de Almeida-Neto PF, bulhões-Correia A, et al. Impact of social isolation on the level of physical activity in young Brazilian athletes caused by COVID-19. *The Journal of Sports Medicine and Physical Fitness*. 2021 Mar. DOI: 10.23736/s0022-4707.21.12198-x. PMID: 33666076.
4. Dönmez, G., Özkan, Ö., Menderes, Y., Torgutalp, Ş. Ş., Karaçoban, L., Denerel, N., & Kudaş, S. (2021). The effects of home confinement on physical activity level and mental status in professional football players during COVID-19 outbreak. <https://doi.org/10.1080/00913847.2021.1888630>
5. Elaine Hargreaves, E. A., Lee, C., Jenkins, M., Calverley, J. R., Hodge, K., & Mackenzie, S. H. (2021). Changes in Physical Activity Pre-, During and Post-lockdown COVID-19 Restrictions in New Zealand and the Explanatory Role of Daily Hassles. *Frontiers in Psychology | Www.Frontiersin.Org*, 12, 642954. <https://doi.org/10.3389/fpsyg.2021.642954>
6. Gautam, S. (2020). COVID-19: air pollution remains low as people stay at home. *Air Quality, Atmosphere & Health* 2020 13:7, 13(7), 853–857. <https://doi.org/10.1007/S11869-020-00842-6>
7. Giustino, V., Parroco, A. M., Gennaro, A., Musumeci, G., Palma, A., & Battaglia, G. (2020). Physical Activity Levels and Related Energy Expenditure during COVID-19 Quarantine among the Sicilian Active Population: A Cross-Sectional Online Survey Study. 12, 4356. <https://doi.org/10.3390/su12114356>
8. Jena, Pravat. (2020). Impact of Pandemic COVID-19 on Education in India. *International Journal of Current Research*. 12. 12582-12586. 10.24941/ijcr.39209.07.2020.
9. Lancet, T. (2020). India under COVID-19 lockdown. *The Lancet*, 395(10233), 1315. [https://doi.org/10.1016/S0140-6736\(20\)30938-7](https://doi.org/10.1016/S0140-6736(20)30938-7)
10. Maria da Silva Santos, A., Eduardo Rossi, F., Pereira dos Santos Nunes de Moura, H., Valdeci Marreiro de Sousa Junior, A., D Machado, D. C., Melo Neves, L., Silva Brito, A., Moura, P., Alves Monteiro, P., Forte Freitas Junior, I., Antonio Pereira dos Santos, M., & Luiz Galan Ribeiro, S. (n.d.). COVID-19 pandemic impacts physical activity levels and sedentary time but not sleep quality in young badminton athletes. 1, 3. <https://doi.org/10.1007/s11332-021-00763-6>
11. Nachimuthu, S., Vijayalakshmi, R., Sudha, M., & Viswanathan, V. (2020). Coping with diabetes during the COVID – 19 lockdown in India: Results of an online pilot survey. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 14(4), 579–582. <https://doi.org/10.1016/J.DSX.2020.04.053>
12. Óscar Martínez-de-Quel, David Suárez-Iglesias, Marcos López-Flores, Carlos Ayán Pérez, Physical activity, dietary habits and sleep quality before and during COVID-19 lockdown: A longitudinal study, 2021, ISSN 0195-6663, <https://doi.org/10.1016/j.appet.2020.105019>.
13. Pérez-Rodrigo, C., Gianzo Citores, M., Hervás Bárbara, G., Ruiz-Litago, F., Casis Sáenz, L., Arijia, V., López-Sobaler, A. M., Martínez de Victoria, E., Ortega, R. M., Partearroyo, T., Quiles-Izquierdo, J., Ribas-Barba, L., Rodríguez-Martín, A., Salvador Castell, G., Tur, J. A., Varela-Moreiras, G., Serra-Majem, L., & Aranceta-Bartrina, J. (2021). Patterns of Change in Dietary Habits and Physical Activity during Lockdown in Spain Due to the COVID-19 Pandemic. *Nutrients*, 13(2), 300. <https://doi.org/10.3390/nu13020300>.
14. Pillay, L., Janse van Rensburg, D. C. C., Jansen van Rensburg, A., Ramagole, D. A., Holtzhausen, L., Dijkstra, H. P., & Cronje, T. (2020). Nowhere to hide: The significant impact of coronavirus disease 2019 (COVID-19) measures on elite and semi-elite South African athletes. *Journal of Science and Medicine in Sport*, 23(7), 670–679. <https://doi.org/10.1016/J.JSAMS.2020.05.016>
15. Trabelsi, K., Ammar, A., Masmoudi, L., Boukhris, O., Chtourou, H., Bouaziz, B., Brach, M., Bentlage, E., How, D., Ahmed, M., Mueller, P., Mueller, N., Hsouna, H., Romdhani, M., Hammouda, O., Paineiras-Domingos, L. L., Braakman-Jansen, A., Wrede, C., Bastoni, S., ... Hoekelmann, A. (2021). Globally altered sleep patterns and physical activity levels by confinement in 5056 individuals: ECLB COVID-19 international online survey. *Biology of Sport*, 38(4), 495–506. <https://doi.org/10.5114/BIOLSPORT.2021.101605>
16. U.S. Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 1996, pp. 188–195.
17. WC, K., E, B.-C., SE, F., RF, H., JM, L., EA, W., & DM, N. (2002). Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *The New England Journal of Medicine*, 346(6), 393–403. <https://doi.org/10.1056/NEJMOA012512>
18. YOUNG, MEM. Et al. The Influences of COVID-19 Lockdown Measures on Physical Activity, Sedentary and Screen Time Behaviour of University Rugby Players in the Western Cape, South Africa. *Medical Research Archives*, [S.l.], v. 10, n. 6, june 2022. ISSN 2375-1924. Available at: <<https://esmed.org/MRA/mra/article/view/2855>>. Date accessed: 18 July 2022. Doi: <https://doi.org/10.18103/mra.v10i6.2855>.