

# **The (In)Accessibility of YouTube Fitness Videos for Disabled Individuals Before and During the COVID-19 Pandemic: A Preliminary Application of a Text Analytics Approach**

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# The (In)Accessibility of YouTube Fitness Videos for Disabled Individuals Before and During the COVID-19 Pandemic: A Preliminary Application of a Text Analytics Approach

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## Abstract

**Background:** Due to widespread lockdowns, many people have had to resort to online resources, such as YouTube, for physical activity (PA) during the COVID-19 pandemic. Barriers to in-person fitness resources for people with disabilities (PWDs), however, have been reported long before the COVID-19 pandemic. To investigate whether fitness content creators on YouTube have made their videos more accessible to PWDs would not only be informative about equitable access to PA during COVID-19, but could also provide insight into the feasibility of disabled individuals relying on YouTube for fitness content in a post-COVID-19 world who have not felt comfortable in more traditional fitness settings, such as gyms.

**Objective:** To ascertain whether a change in the availability of accessible fitness resources for PWDs occurred on YouTube between before and during the COVID-19 pandemic. Secondary aims are to investigate if different categories of YouTube channels produce more accessible fitness content and highlight any disparities in disability-friendly physical activity content on YouTube.

**Methods:** A cross-sectional text analysis of exercise-related YouTube videos was conducted. The authors used Python (version 3.0) to access the YouTube database via its Data Application Programming Interface (API) and search videos with terms of interest. Terms pertaining to physical activity that were searched on YouTube to find exercise-related videos include: 'at home exercise,' 'exercise at home,' 'exercise no equipment,' 'home exercise,' 'home-based exercise,' 'no equipment workout,' and 'workout no equipment.' Various elements (e.g., view count, content generation) of the videos published between 01/01/2019 and 06/30/2019 (n=700), were compared to the elements of videos published between 01/01/2020 and 06/30/2020 (n=700). To ascertain a broad idea of disability-friendly videos on YouTube, videos were labeled "accessible" if they were found in the first 100 video results and if their title, description(s) or tags contained the following terms: 'Para,' 'Paralympic,' 'Adaptive,' 'Adapted,' 'Disabled,' 'Disability,' 'Differently-abled,' 'Disability-friendly,' 'Wheelchair accessible,' and 'Inclusive.'

**Results:** Removing video duplicates that reappeared in term searches resulted in 1038 unique videos (508 in 2019 and 530 in 2020). The analysis revealed that accessible terms applicable to PWDs had minimal appearances in 2019 (21 videos) and 2020 (19 videos). None of the first ten fitness videos that populated on YouTube from 2019 or 2020 were accessible.

**Conclusions:** During the COVID-19 pandemic, there was a slight decrease in the number of accessible PA videos on YouTube. This suggests that the proportion of accessible disability-friendly videos remains diminutive relative to the prevalence of disability in the general population, revealing that disability-friendly videos are seldom findable on YouTube. Thus, the need for disability-friendly fitness content to be easily searched and found remains urgent if access to digital fitness resources is to

improve.

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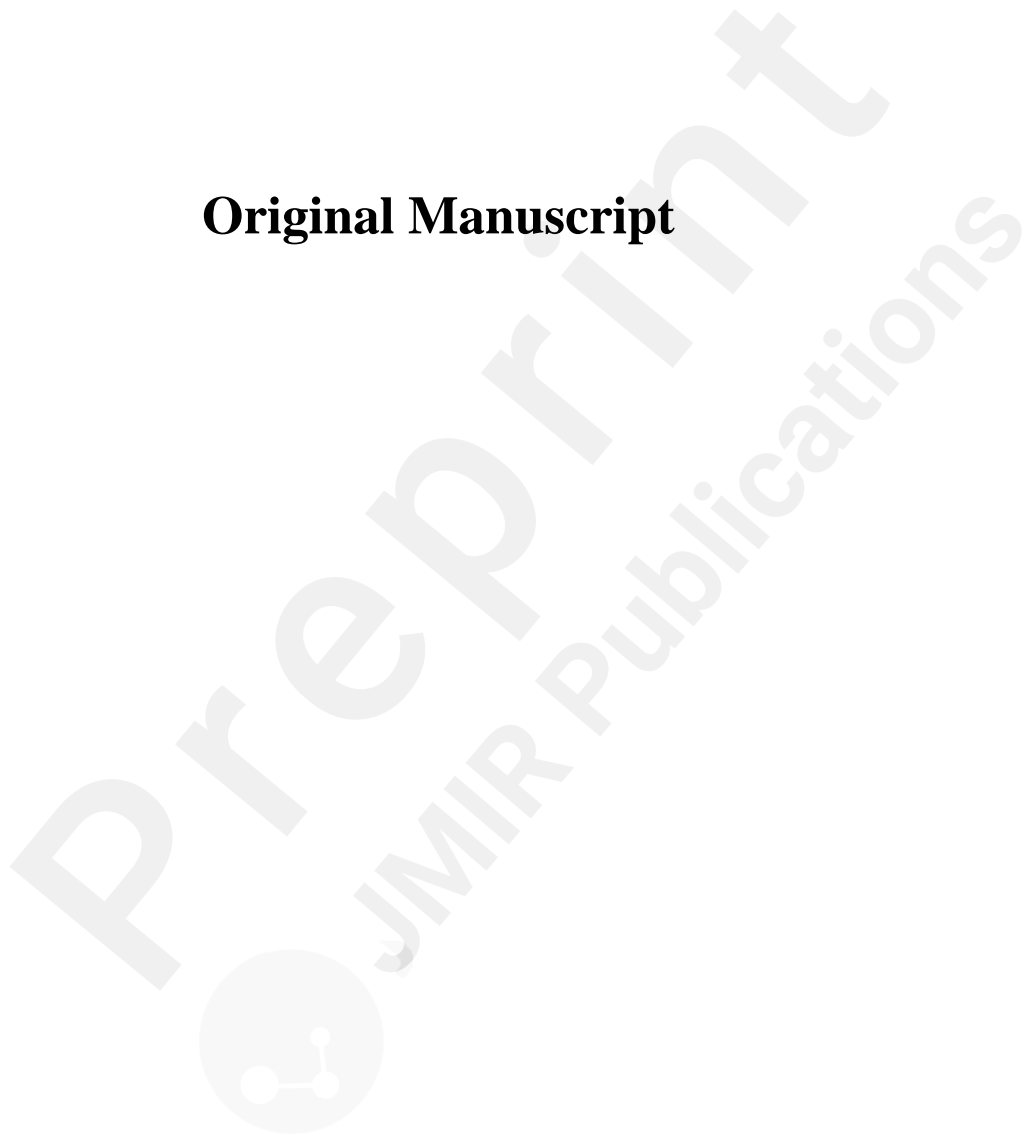
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## The (In)Accessibility of YouTube Fitness Videos for Disabled Individuals Before and During the COVID-19 Pandemic: A Preliminary Application of a Text Analytics Approach

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### Abstract:

**Background:** People with disabilities (PWDs) face barriers to in-person physical activity (PA),

including a lack of adaptive equipment and knowledgeable instructors, and feeling dissonance with gym culture. Given this, and the increased need for digital resources due to widespread COVID-19 lockdowns, it is necessary to assess the accessibility of digital fitness resources for PWDs. To investigate whether YouTube fitness content creators have made their videos accessible to PWDs would be informative about access to PA during COVID-19 and could also provide insight into the feasibility of disabled individuals, who have not felt comfortable in more traditional fitness settings, relying on YouTube for PA in a post-COVID-19 world.

**Objectives:** To ascertain the accessibility of disability-friendly PA videos on YouTube by searching general fitness terms and whether a change in the availability of accessible fitness resources for PWDs occurred on YouTube between before and during the COVID-19 pandemic on “Hospital/Medical Institutions”, “Individual(s)”, and “Other(s)” channels. Secondary aims are to investigate if different categories of YouTube channels produce more accessible fitness content and highlight any disparities in disability-friendly physical activity content on YouTube.

**Methods:** A cross-sectional text analysis of exercise-related YouTube videos was conducted. The authors used Python (version 3.0) to access the YouTube database via its Data Application Programming Interface (API) and search videos. Terms pertaining to PA that were searched on YouTube to find exercise-related videos include: ‘at home exercise,’ ‘exercise at home,’ ‘exercise no equipment,’ ‘home exercise,’ ‘home-based exercise,’ ‘no equipment workout,’ and ‘workout no equipment.’ Various elements (e.g., view count, content generation) of the videos published between 01/01/2019 and 06/30/2019 (n=700), were compared to the elements of videos published between 01/01/2020 and 06/30/2020 (n=700). To ascertain a broad idea of disability-friendly videos on YouTube, videos were labeled “accessible” if they were found in the first 100 video results and if their title, description(s) or tags contained the following terms: ‘Para,’ ‘Paralympic,’ ‘Adaptive,’ ‘Adapted,’ ‘Disabled,’ ‘Disability,’ ‘Differently-abled,’ ‘Disability-friendly,’ ‘Wheelchair accessible,’ and ‘Inclusive.’ Each video and channel were categorized based on whether the channel is run by

“Hospitals/Medical Institutions”, “Individuals” or “Other(s),” with analytic emphasis on “Hospitals/Medical Institutions” given their greater credibility to provide disability-friendly PA instruction.

**Results:** Removing video duplicates resulted in 1038 unique videos (508 in 2019 and 530 in 2020). The analysis revealed a statistically significant increase in viewership of fitness content on YouTube ( $P = 0.0012$ ) and in fitness content generated by Hospitals/Medical Institutions ( $P = 0.004$ ). Accessible terms applicable to PWDs had minimal appearances in 2019 (21 videos) and 2020 (19 videos). None of the top viewed fitness videos that populated on YouTube from 2019 or 2020 were accessible.

**Conclusions:** The proportion of accessible disability-friendly videos remains diminutive relative to the prevalence of disability in the general population, revealing that disability-friendly videos are seldom findable on YouTube. Thus, the need for disability-friendly fitness content to be easily searched and found remains urgent if access to digital fitness resources is to improve.

**Keywords:** Persons with Disabilities (PWDs), Disability, Exercise, Physical Activity, Digital Health, YouTube

## **Introduction:**

### *Background*

Physical activity (PA) is a critical health strategy for the prevention and maintenance of strong physical and mental health as well as upholding a high quality of life [1-4]. There is strong evidence that people with disabilities (PWDs) report markedly lower rates of PA than their abled-bodied peers [1-4]. For example, according to one study, only 45% of Americans adults with a mobility disability participated in aerobic PA [5]. This lower rate of PA, in part, explains how PWDs



present with serious illnesses such as obesity, heart disease, stroke, diabetes, and cancer at higher rates than the general population. Therefore, strategies to address these barriers should be developed [1].

Disabled persons have often struggled to access exercise trainers and equipment due to a lack of social support in the fitness and sports sectors, insufficient knowledge of disability amongst fitness instructors and/or a shortage of adaptive fitness resources in gyms [3, 4, 6]. For example, Richardson et al conducted semi-structured interviews with individuals with disabilities about their experiences with the gym [4]. While several participants indicated that they believed the gym could have the power to improve their physical wellness and social engagement, they also noted that their experiences were often at odds with the gym's culture [4]. This proves to be an extreme setback as it has been documented that PWDs tend to be more willing to participate in physical activity if the gym instructor has medical knowledge of their particular diagnosis or disability [3, 4, 7]. In fact, one study conducted by the Lakeshore Foundation in collaboration with Degree<sup>®</sup> found that 81% of PWDs feel uncomfortable using traditional gym and fitness spaces and resources [8]. The reasons for this include, but are not limited to, having greater trust in the source of instruction and greater comfort in the safety of physical activity if it is being led by someone who would understand the manifestations and possible limitations of a particular diagnosis [7]. These barriers will require systemic change. In the interim, it is possible that PWDs might consider alternative modes of PA, such as accessing digital fitness resources.

Understanding the accessibility of fitness resources for PWDs on social media platforms such as YouTube could be beneficial for them since some PWDs who have discomfort towards in-person fitness settings might be more inclined to use online resources. Thus, considering the need for at-home PA resources due the social deterrents associated with in-person PA for some PWDs, investigations into the accessibility of digital fitness resources as an alternative for PWDs are timely and warranted.

Furthermore, the coronavirus disease 2019 (COVID-19) pandemic has increased our dependencies on digital options for activities such as fitness [9-13]. Though increases in physical activity content on YouTube have not been widely reported, individuals and groups of people creating fitness content on YouTube have seen significant spikes in metrics of engagement with digital resources, such as their number of subscribers and views [14]. For example, more patients have begun relying on Hospital/Medical Institutions' online fitness sessions to improve their stress and anxiety [15]. Not only has research has found that engaging in physical activity online can be effective in providing the same benefits of more traditional modes of physical activity [16], but also transitioning to the virtual space has resulted in some benefits, one being the larger audience with whom fitness instructors interact [17, 18]. An example of this includes The University of Milan's '#StayHomeStayFit' movement. This movement reached over 21,000 people, which is a 100-fold increase compared to their prior in-person fitness classes [19]. Given the increasing popularity of digital PA resources, it is important to determine if their accessibility has extended to the disability community as well. Moreover, the unique barriers to in-person PA resources for PWDs make investigations into the accessibility of digital fitness resources for PWDs, and how these resources could be extended in a post-pandemic world, critical.

While there could be a shortage of digital PA resources for PWDs, the authors acknowledge that such content may exist on YouTube as well. Our principal concern is how easily this content can be discovered for use when general terms related to fitness are used. If a PWD spends disproportionate amount of time searching for accessible videos and/or cannot successfully identify it, they are not having an equitable experience to that of their abled-bodied peers. Therefore, the existence of disability-friendly content - content that is created for or adaptable to PWDs – is not the focus of this study. Instead, the authors are investigating whether disability-friendly content can be easily found using common search terms.

### *Prior Work*

Many studies have been conducted on YouTube videos, but few have analyzed the accessibility of YouTube videos for PWDs. Most prior work concerns the accessibility of physical fitness centers for disabled persons, not the accessibility of online fitness content [20-22]. Thus, to the authors' best knowledge, no studies have analyzed this matter.

### *Objectives*

This study has two primary objectives. The first is to assess how frequently disability-friendly accessibility terms are used in YouTube fitness videos when users search general PA terms. The second primary objective is to determine if there were changes in the accessibility of disability-friendly physical activity resources on YouTube between before and during the COVID-19 pandemic. Secondary aims are to ascertain if certain types of channels produce more accessible fitness content, and to highlight disparities in accessing fitness opportunities on YouTube for PWDs, if any exist.

### **Methods:**

#### *Video Collection for Study Analysis*

A cross-sectional text analysis of exercise- and fitness-related YouTube videos was conducted. Data about videos published from 01/01/2019 to 06/30/2019 ("pre-pandemic") and from 01/01/2020 to 06/30/2020 ("during COVID-19 pandemic") were collected using the following search physical activity terms: 'at home exercise,' 'exercise at home,' 'exercise no equipment,' 'home exercise,' 'home-based exercise,' 'no equipment workout,' and 'workout no equipment.' The authors recognize that other fitness terms could be used, such as terms referring to a specific sport (i.e. "basketball"), but this investigation aims to capture the experience using YouTube for PA for the general public rather than for smaller groups of individuals who play specific sports. General terms related to fitness were searched instead of specific terms related to PWD as the study's purpose is to determine whether mainstream PA videos include accommodations for PWDs. January 2020 was deemed a starting date for COVID-19 videos given that this is when the first lockdown in the world

was reported [23].

In lieu of a random sample, we sought to replicate the YouTube video search process in order to make practical conclusions about the experience of finding accessible videos on YouTube. Prior work suggests that 95% of YouTube traffic is on the first page of search results, which contains 20-30 videos [24]. Thus, to establish a rigorous sample size that captures the videos most viewers access, this study collected the first 100 videos that populated on YouTube for each physical activity search term in both 2019 and 2020. Videos were eligible for inclusion regardless of the country of its creation as long as the videos were created in the English language so that they would be searchable to the study investigators. The authors used Python (version 3.0) to access the YouTube database via its Data Application Programming Interface (API) [25]. To de-identify the collected data, YouTube channels and videos were labelled as channel or video as “1, 2, 3...”

#### *Defining “People with Disabilities (PWDs)” and “Disabled Individuals”*

These two terms are used interchangeably to reflect a balanced use of disability-friendly language. For the purpose of this study, PWDs refer to any individual who self-identifies with a physical, psychological, and/or intellectual disability. Since this is a preliminary investigation into disability-friendly content on YouTube, the authors are not framing the definition of disabled individuals around a specific diagnosis or criteria. The authors are more concerned with whether the yielded content includes accessibility terms, and less so with who is searching for these terms and if they have a particular disability.

#### *Measuring “Accessibility”*

While there may be videos on YouTube that contain disability-friendly content, if they cannot be efficiently found, their utility to PWDs diminishes. Therefore, for the purposes of this preliminary assessment of accessible physical activity videos on YouTube, a video was deemed “accessible” if it was found in the first 100 results from the PA search terms and if its title, tags, or description contained one of the following accessibility terms: ‘Para,’ ‘Paralympic,’ ‘Disabled,’ ‘Disability,’

‘Differently abled,’ ‘Disability-friendly,’ ‘Wheelchair-accessible,’ ‘Adaptive,’ ‘Adapted,’ or ‘Inclusive.’ These terms were not used in the initial search for PA content since the investigators wanted to ascertain how common accessibility terms are used within commonly searched and viewed PA videos.

The authors acknowledge that videos meeting these criteria still may not be accessible to all users and that additional terms may be appropriate. However, the authors agreed that the above terms were appropriate and should be analyzed. ‘Para’ or ‘Paralympic’ have an implication that combines disability-identifying individuals with sport and/or fitness [26]. The terms ‘Disabled,’ ‘Disability,’ ‘Differently abled,’ and ‘Disability-friendly’ were selected since they are all centered around the word “disability”. It should be noted that while the authors will not use the term ‘Differently abled’ to refer to PWDs since the term is generally opposed within the disability community [27], it is still frequently used and therefore should be searched to better ascertain what terms content generators might use to describe disability-friendly content [28]. The term ‘Wheelchair-accessible’ was included since many disabled individuals use wheelchairs, and all these individuals face similar challenges in accessing fitness resources [21]. ‘Adaptive,’ ‘Adapted,’ or ‘Inclusive’ were analyzed because while as stand-alone terms they do not necessarily denote disability-friendliness, when combined with words associated with PA, the connotation becomes stronger. The concept of inclusive sport and fitness has shaped an association with disability [29, 30].

#### *Parameters Collected from Videos*

Since video titles and YouTube channel names alone often do not provide comprehensive descriptions of video content, video tags (words and/or phrases creators choose with which to associate their videos) and video descriptions were also gathered and analyzed. Frequencies of the appearance of “accessible” terms in video tags, descriptions, and titles were recorded.

#### *Data Analysis*

Words with the greatest frequencies of appearance in the video titles, tags, and descriptions

were collected to assess potential differences in how content generators were describing and tailoring their videos, and if accessibility terms were among the words with greatest frequency. Other collected metrics were compared between 2019 and 2020 content, including the view counts of the generated videos. Frequent consecutive wording pairs (“bigrams”) were compiled within the included video using the tidytext package (version 0.3.1) in R because bigrams can be programmed to remove extraneous words such as “or” and “the” which do not speak to unique context or physical activity YouTube videos thereby giving better insight into the video’s specific content. For example, the words “Yoga for neck pain” would generate “yoga” and “neck” as one bigram and “neck” and “pain” as another bigram. If a hyperlink or name was generated in bigrams, it was replaced with the annotation, “[hyperlink]” “[omitted first name]” or “[omitted last name]”.

### *Categorization of Channels*

Each video and channel was categorized based on whether the channel is run by “Hospitals/Medical Institutions”, “Individuals” or “Other(s)”. Videos published on a hospital or medical institution’s channel were categorized separately from videos created by individuals - a singular person unaffiliated with an established hospital, medical institution, or practice. Remaining videos were placed in the “Other(s)” category. Examples include a certified hospital being placed in the “Hospitals/Medical Institutions” category, a singular person creator being placed in the “Individual” category, and a group creator placed in the “Other” category. This categorization provided greater insight into which content generators are producing the most accessible disability-friendly exercise content on YouTube before and during COVID-19. Attention was given to Hospital/Medical Institutions channels given that PWDs report greater comfort with receiving PA instruction from medical professionals [4]. The creditability of “Individual(s)” channels, however, cannot be verified with as much ease. Therefore, PWDs may be reluctant to use them as frequently for PA. Further, given their expertise with PWDs, Hospital/Medical Institutions might be more inclined to implement accessible terms when posting PA resources during COVID-19 [8, 15]. The initial text analysis (e.g.,

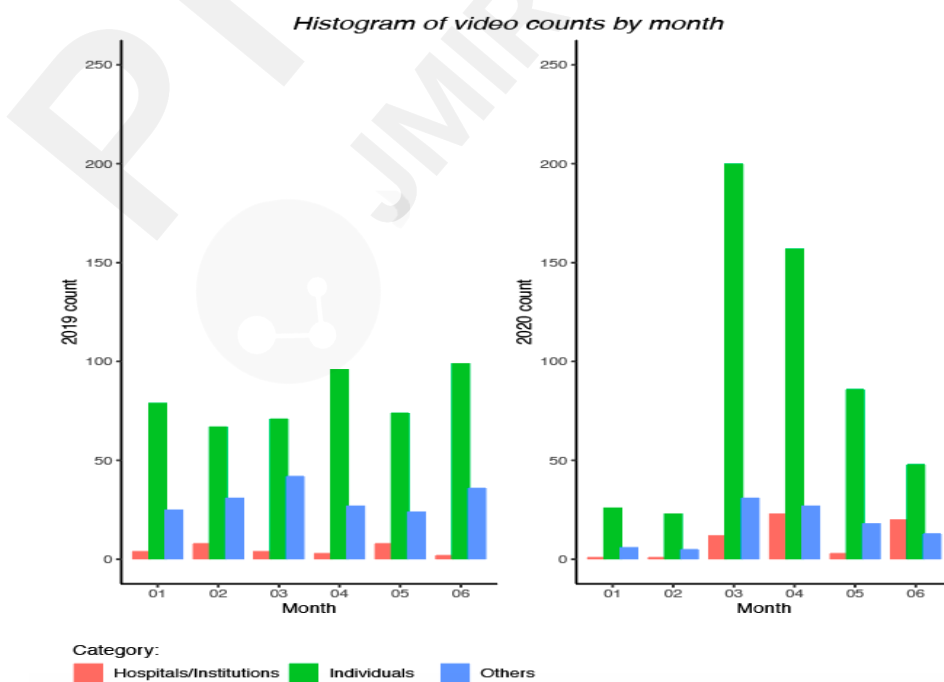
search terms such as ‘exercise no equipment’) and the subsequent text analysis for disability-friendly terms (e.g., search terms such as ‘Adaptive’) were compared across the categories including a chi-square test on the change in video generation by Hospitals/Medical Institutions between 2019 and 2020.

## Results:

Video titles, descriptions, tags, and transcriptions were collected for a total of 1400 physical activity videos between 2019-2020. The 1400 videos include the first 100 videos to populate for each of the seven physical activity search terms created in each year (2019 and 2020). Removing duplicate videos resulted in 1038 unique videos (508 in 2019 and 530 in 2020). Viewership in 2020 of content created in 2020 increased significantly when compared to the viewership in 2019 of content created in 2019 with median video view counts of 52,288 (IQR: 2,891-401,879) and 122,837 (IQR: 7,257-728,854) for 2019 and 2020, respectively ( $P = 0.0012$ ).

The analysis revealed that accessible terms applicable to PWDs had minimal appearances in 2019 (21 videos) and 2020 (19 videos) among the 1038 unique videos.

**Figure 1: Histogram of Total Videos Published from January to June in 2019 and 2020**



Considering the three domains of interest, “Hospitals/Medical Institutions”, “Individuals”,

and “Others”, each generated more exercise-related videos during January-June 2020 when compared to 2019 (Figure 1). Among the top ten fitness content generators on YouTube with the most views on their videos, none were Hospitals/Medical Institutions in 2019, and one was a Hospitals/Medical Institutions channel in 2020 (Table 1). After accounting for 29 of the 508 unique videos from 2019 (6%), Hospitals/Medical Institutions generated 60 of the 530 videos from 2020 (11%) (Figure 1). To investigate whether the proportion of the most viewed videos created by Hospitals/Medical Institutions had increased significantly in 2020, a chi-square test was conducted which revealed a moderate, but statistically significant increase (5%) in physical activity content generated on YouTube by Hospitals/Medical Institutions channels ( $\chi^2 = 8.1476, P = 0.004$ ).

**Table 1: Top Ten Fitness Channels on YouTube in 2019 and 2020 (Based on Video Views)**

<b>De-identified Channels (2019)</b>	<b>Channel View Count as of June 2020 (rounded to nearest million)</b>	<b>Category (2019)</b>	<b>De-identified Channels (2020)</b>	<b>Channel View Count as of June 2020 (rounded to nearest million)</b>	<b>Category (2020)</b>
1	29	Individuals	1	34	Individuals
2	28	Others	2	28	Individuals
3	25	Individuals	3	22	Individuals
4	17	Individuals	4	21	Hospitals/ Medical Institutions
5	14	Individuals	5	18	Individuals
6	13	Others	6	15	Individuals
7	13	Individuals	7	13	Individuals
8	13	Others	8	12	Others
9	13	Individuals	9	12	Individuals
10	13	Individuals	10	10	Others

When the PA terms were searched, none of the study’s accessible terms populated in the 20 words with the largest aggregate word counts or the top 10 most frequently used word-pairs (bigrams) for 2019 and 2020. (Table 2, Table 3). In 2020, two bigrams were tied in tenth place resulting in 11



bigrams being reported.

**Table 2: Top 20 Words with Largest Aggregate Word Count of 1400 Video Descriptions in 2019 and 2020 (Excludes Filler Words)**

Year	Word	Number of Word Appearances	Year	Word	Number of Word Appearances
2019	workout	139	2020	workout	150
	home	88		home	109
	https <sup>1</sup>	46		https	56
	body	42		body	41
	exercise	42		video	35
	video	38		minute	34
	minute	30		5	32
	5	27		exercise	32
	fat	26		equipment	27
	equipment	25		fat	26
	exercises	24		free	26
	abs	23		abs	25
	10	20		ready	23
	free	20		hiit	22
	http	20		min	22
	hiit	18		exercises	21
	min	18		10	20
	cardio	15		burn	19
	download	15		visit	19
	visit	15		join	18

**Table 3: Top 10 Bigram Counts of 1400 Video Descriptions in 2019 and 2020**

Year	Bigram	Number of Bigram Appearances	Year	Bigram	Number of Bigram Appearances
2019	home workout	19	2020	home workout	21
	visit https	15		visit https	19
	https [hyperlink]	13		https [hyperlink]	18
	body workout	12		abs workout	17
	home exercise	12		[omitted first name] [omitted last name]	14
	abs workout	11		5 minute	13
	5 minute	9		join [omitted first name]	13

1 Before tokenization (text parsing), symbols are converted into white space. Accordingly, 'http' was kept in the word tally after symbol removal from any embedded link in the video description.

	10 minute	8		body workout	12
	cardio workout	8		home exercise	10
	[omitted first name] [omitted last name]	8		10 minute	8
	-			body home	8

All of the top five viewed videos created by Hospitals/Medical Institutions, Individuals, and Others in 2019 and 2020 were inaccessible (Table 4).

**Table 4: Top 5 Fitness Viewed Videos by Hospitals/Medical Institutions, Individuals and Others in 2019 and 2020**

Year	Category	De-identified Video Titles	Accessible or Not Accessible	View Count as of June 2020	
2019	Hospitals/ Medical Institutions	1	Not Accessible	857,433	
		2	Not Accessible	400,604	
		3	Not Accessible	325,860	
		4	Not Accessible	320,632	
		5	Not Accessible	308,392	
	Individuals	1	Not Accessible	31,972,886	
		2	Not Accessible	23,421,718	
		3	Not Accessible	23,421,342	
		4	Not Accessible	23,418,009	
		5	Not Accessible	23,292,783	
	Others	1	Not Accessible	29,604,801	
		2	Not Accessible	29,600,357	
		3	Not Accessible	29,414,241	
		4	Not Accessible	12,927,417	
		5	Not Accessible	12,924,144	
2020	Hospitals/ Medical Institutions	1	Not Accessible	3,108,295	
		2	Not Accessible	1,708,937	
		3	Not Accessible	58,240	
		4	Not Accessible	44,078	
		5	Not Accessible	14,616	
	Individuals	1	Not Accessible	24,521,523	
		2	Not Accessible	22,420,881	
		3	Not Accessible	19,890,094	
		4	Not Accessible	19,484,086	
		5	Not Accessible	15,835,194	
			1	Not Accessible	18,331,311
			2	Not Accessible	3,589,580

Others	3	Not Accessible	2,900,454
	4	Not Accessible	2,251,818
	5	Not Accessible	2,174,462

## Discussion:

While there was a statistically significant increase in the number of videos created by Hospitals/Medical Institutions in the top viewed videos over the study period, none of the videos by these creators were accessible by our study's definition. The authors created their definition of accessible by considering that 'disability' encompasses visible impairments such as amputations, and invisible disabilities like chronic pain and disease [31-33]. Before the pandemic, many PWDs would have benefitted from digital resources since they struggled to find adequate fitness programs due to inaccessible buildings, classes, equipment, costs or social inclusion [6]. During the pandemic, the need for digital resources was heightened due to lockdowns. The statistically significant increase in views on PA videos on YouTube during the COVID-19 reflects the increased dependency on digital resources during the pandemic. The absence of a proportional increase in videos using the study's accessibility terms, however, reinforces the need for YouTube content to be more accessible for PWDs and that higher viewership does not necessarily correlate with greater utility.

As full participants in this active social media platform [34], persons with diverse disabilities and ailments could benefit from popular YouTube channels including accommodations for PWDs. While more content curated for or adaptable to PWDs may exist, it is unfair for PWDs to be excluded from videos that serve the general population, especially given that over 1 billion people have a disability globally [35]. YouTube content creators are encouraged to include some accommodations for PWDs in their PA videos to make fitness a more inclusive environment.

The analysis of the most frequently used 20 words and word-pairs in video descriptions showed no words applicable to PWDs, even after reviewing the list for potentially relevant terms not part of the study's accessible terms. This suggests that most of the content created for at-home

exercises were either not inclusive of disabled persons or would be quite difficult for PWDs to find. Not being in the first 100 results shown by YouTube means that the content will rarely be accessed because users rarely look beyond the first page of results.

The current analysis shows that the standards for giving everyone equal access opportunities are not being met. In this sense, the COVID-19 crisis has further exposed and exacerbated pre-existing social inequities such as disability stigma and ableist attitudes [36-38]. A particularly damaging form of ableism is the reality that disabled persons are often invisible to mainstream citizens, programs and policies. Despite the global burden of disability for instance, even sweeping international policies have been called out for omitting and failing to consider the experiences of disabled people [39].

Beyond YouTube, however, it is encouraging that the COVID pandemic has accelerated action in grassroots and international advocacy groups, as they increasingly recognize the imperative need for digital inclusiveness -- including with exercise, health and fitness content. Mooven, an online resource center, was created in response to the stay-at-home orders. With the help of the International Federation of Adapted Physical Activity, Mooven offers guidance and feedback on exercises [40]. Additionally, the non-profit Inter Campus uses sports to develop resilience in children and help them cope through the pandemic. On the European front, many programs are taking action to adequately prepare trainers to work with PWDs [41]. For digital media access, the Universal Fitness Innovation & Transformation organization created a repository of fitness content specifically for disabled persons and persons with chronic pain [42]. And finally, in regard to overall connectivity, a UNICEF program increases internet connection for children in 11 different countries [43]. These programs' work to increase outreach provides a positive outlook on the increased accessibility of sports.

### *Limitations and Next Steps*

This preliminary assessment of the availability and searchability of disability-friendly fitness videos on YouTube has several limitations which could be addressed through subsequent studies.

The first limitation is selection bias of search terms. The authors sought to select sensible terms that were conducive to both exercise and disability-friendly content. This approach did populate videos focused on specific disabilities. The investigators are aware, however, there are other terms that could fulfill the same purpose and therefore, potentially relevant terms were not all included in this study. As acknowledgement of this, the investigators consider this study a preliminary study focusing on accessible fitness content on YouTube for disability in general. We plan to conduct a similar study in the future that will focus on specific disabilities which will provide the opportunity to search for more targeted results. The investigators will begin with a search for fitness content targeted for patients with “stroke,” “cerebral palsy (CP),” “multiple sclerosis (MS),” and “rheumatoid arthritis.” Additionally, cross-sectional methodology introduces inherent limitations related to generalizability. To manage this bias, the investigators selected a point in time where there was a reasonably suspected shift in video curation on YouTube given the COVID-19 pandemic.

This study solely sought to assess how a generic YouTube user could find disability-friendly content. In other words, the investigators cannot conclude from this investigation if PWDs find the videos useful or the proportion of viewers that disabled persons account for. A future study that would be merited would be a qualitative study into PWDs’ experiences with YouTube as a fitness resource. Given the cited preference among some PWDs for content created by relevant experts [8] and the fact that the overall increase in fitness content created by Hospitals/Medical Institutions on YouTube during COVID-19 did not translate to a meaningful increase in accessible content, another future study would include analyzing accessibility of disability-friendly videos only created by Hospitals/Medical Institutions. Members of the disability community have previously identified safety as an important variable in their decision to engage in physical activity [44,45]. While it is possible for “Individual” or “Other” channels to provide safe physical activity options for PWDs, not

all “Individuals” will have experience working with PWDs unlike Hospitals/Medical Institutions. If safety is a key determinant of engagement, PWDs may be dissuaded from participating. Thus, understanding the amount of content that Hospitals/Medical Institutions create can provide further insight into the accessibility of exercise videos available on YouTube.

Another limitation is that the official beginning of lockdowns varied per country. This may have affected the quantity of content created during each month analyzed in this study. Despite this, there were lockdowns as of January 2020 which justifies this choice for the study. A future study could analyze fitness videos created only in certain countries and limit the search to the dates where lockdowns were in place in that country.

Videos analyzed for this project were limited to being in English so they could be searchable to the study investigators. This may have resulted in videos created in different languages being excluded from this study. To get a more comprehensive understanding of all PA videos, a future study could analyze videos created in multiple languages.

### *Conclusions*

This study concludes that current YouTube general fitness content is either lacking in disability-friendly content or the content is not easily accessible for disabled YouTube users. Despite the COVID-19 galvanizing a broader appreciation for seeking physical activity digitally, this YouTube analysis found there were no increases in accessible disability-friendly exercise content since the pandemic, including Hospitals/Medical Institutions which have been a source of trust and engagement for the disability community. Increasing disability-friendly fitness content will be important for improving barriers to digital fitness resources within the disability community in a post-COVID era.

**Conflicts of Interest:** None reported



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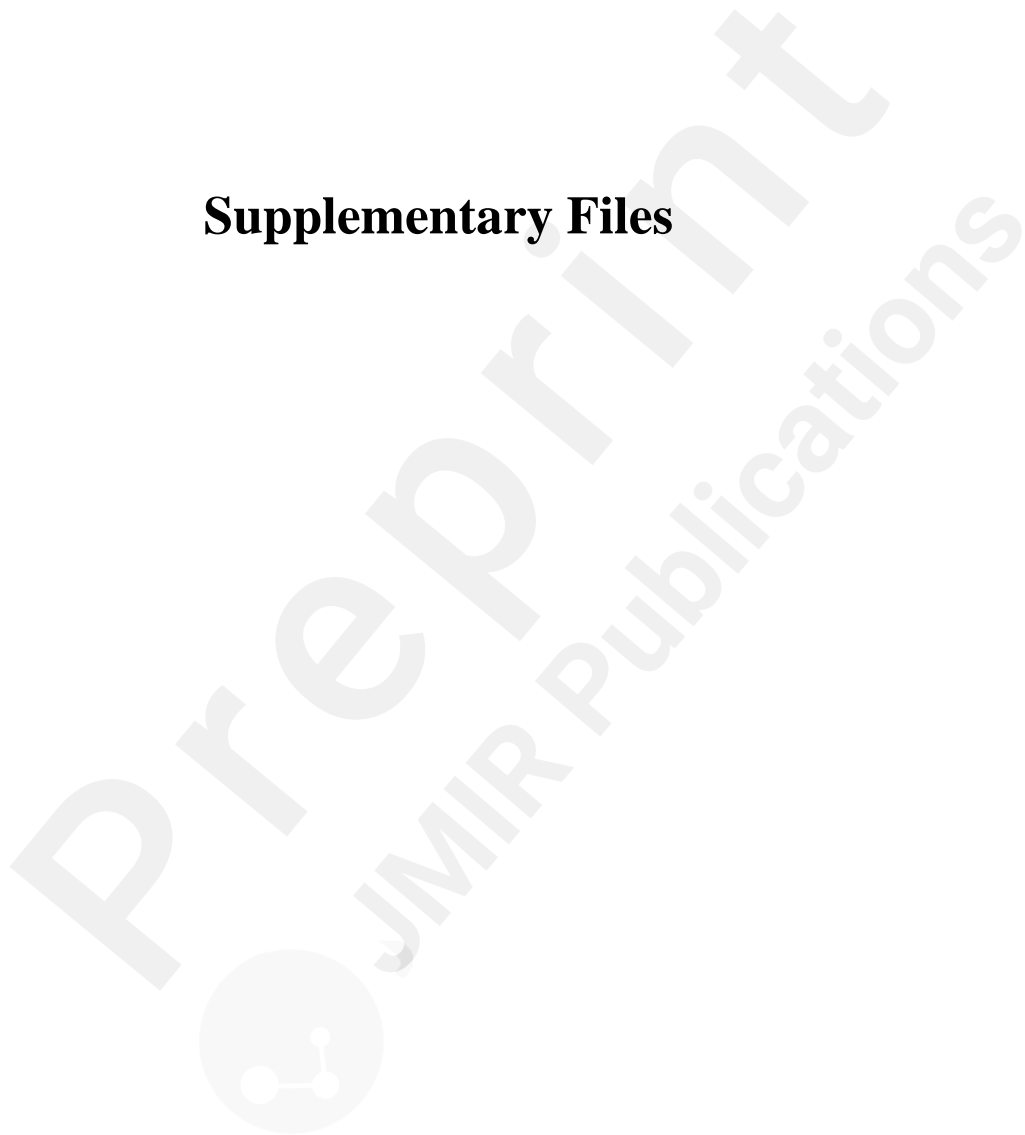
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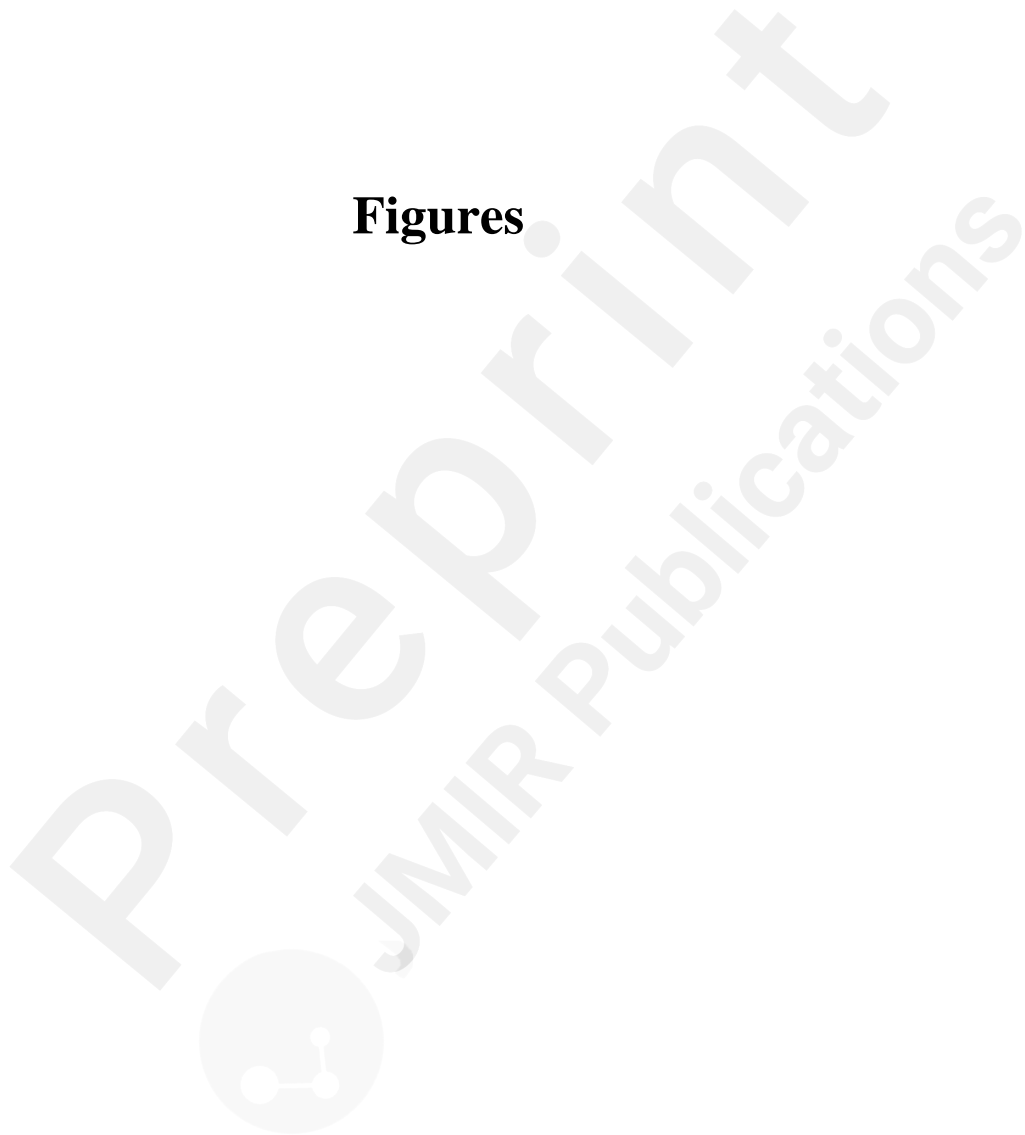
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## Supplementary Files



## Figures





Histogram of Total Videos Published from January to June in 2019 and 2020.

