Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Influence of grit on lifestyle factors during the COVID-19 pandemic in a sample of adults in the United States

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ABSTRACT

The novel coronavirus disease (COVID-19) has profoundly impacted the world, including disruptions in lifestyles to support physical distancing. It is well known that personality plays a role in lifestyle behaviors such that certain traits predict health and well-being. The present study examined the relationship between grit and lifestyle behaviors during the early stages of the COVID-19 pandemic and initial lockdowns in the United States. It was hypothesized that those with more grit would engage in healthier lifestyle behaviors of increased physical activity, less sedentary time, and better eating habits. Using an internet-based survey, data was collected from adults from April 13th to May 4th, 2020. Survey questions focused on demographics, grit, physical activity and sedentary time, and dietary habits. Associations between grit and lifestyle were examined using a combination of hierarchical multiple regression analyses and ANCOVAs. The sample of 888 adults (age: 34.8 ± 14.0) was 74.2% female. Those with higher grit were more physically active, reported less sedentary time, and practiced better dietary habits. Collectively, these findings suggest that grit may help individuals lead a healthier lifestyle during stressful or negative events such as a global pandemic. Future work should examine the role of grit on lifestyle behaviors as the quarantine continues.

1. Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), has infected and killed over 1,476,000 people worldwide as of December 2020 (Johns Hopkins University and Medicine Coronavirus Resource Center, n.d.). Prevention and control strategies put in place to help curb the spread of the COVID-19 pandemic include locking down entire cities, travel restrictions, curfews, and home quarantine that interrupt routine daily behaviors that comprise one's lifestyle. Closed gyms, limited group gatherings, and social distancing restrict and/or limit the ability to participate in various forms of exercise (Hossain et al., 2020), ultimately compromising physical fitness. Decreased physical activity can also worsen mental health (O'Connor & Puetz, 2005; Rebar et al., 2015), which has been exacerbated during the COVID-19 pandemic (Galea et al., 2020; van Tilburg et al., 2020). Closures of food suppliers, limited access to fresh food, and the psychological consequences of quarantine (e.g., anxiety, boredom, etc.) can negatively influence food behaviors towards consuming more food and food of poorer quality (Ammar et al., 2020). Poor physical fitness and impaired nutritional habits can compromise the immune system and the ability to cope with infections (Calder et al., 2020; Nieman & Wentz, 2019). Although public health messaging strongly encourages continuing physical activity in the home to stay healthy and maintain immune system function (Sallis et al., 2020), recent data from Asia, Africa, Europe, and South America suggest the nationwide shut downs have compromised physical activity levels, increased sedentary behaviors, and negatively impacted eating habits (Ammar et al., 2020; Di Renzo et al., 2020; Meyer et al., 2020; Qin et al., 2020; Ruiz-Roso et al., 2020; Smith et al., 2020). The implications of these poor lifestyle behaviors extend beyond the short-term weakening of the immune system to longer term consequences of chronic sedentary behaviors, obesity, and increased cardiovascular disease risk.

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A large body of research has investigated the role various personality traits play in lifestyle behaviors of physical activity and eating habits (Elfhag & Morey, 2008; Goldberg & Strycker, 2002; Rhodes & Smith, 2006); a recent meta-synthesis of 36 meta-analyses including over 500,000 participants concluded that personality predicts overall health and well-being (Strickhouser et al., 2017). The authors are unaware of existing research relating personality to lifestyle behaviors during a pandemic; however, it is likely that personality traits can predict those that will overcome the disappointment, uncertainty, and boredom that accompany long-term quarantine and participate in more positive lifestyle behaviors. Duckworth and colleagues articulated the concept of 'grit' – encompassing two components of sustained persistence towards long-term achievement and consistency of interest; grit incorporates personality traits of resilience, ambition, conscientiousness, endurance, and self-control (Duckworth & Quinn, 2009). Individuals who are gritty are more self-controlled and will maintain a positive attitude over time despite failure, adversity, and plateaus in progress (Duckworth et al., 2007). Subsequent work has reported positive associations between grit and mental well-being (Kannangara et al., 2018) and grit and emotional stability during stressful or negative life events (Blalock et al., 2015), as well as negative associations between grit and perceived stress (Kannangara et al., 2018). Although grit as a construct has not been studied in the context of the COVID-19 pandemic specifically, resiliency, an aspect measured in grit, has been shown to moderate the effects of the COVID-19 pandemic-related stress on emotional health (Labrague & De los Santos, 2020; Yıldırım & Solmaz, 2020).

Grit has primarily been studied in the context of achievement and performance outcomes (Duckworth & Gross, 2014; Eskreis-Winkler et al., 2014; Maddi et al., 2012). Perseverance towards a goal, one of the two major components of grit (Duckworth & Quinn, 2009), is important for adopting healthy behaviors. Conscientiousness, an aspect measured in grit, is highly correlated with perseverance (Rimfeld et al., 2016). The "invest-and-accrue" model of conscientiousness suggests that individuals high on the conscientious personality trait invest in behaviors that allows for future successes (Hill & Jackson, 2016); in other words, conscientious people will invest in behaviors to improve their future health. A study in 650 older adults (>65 years of age) found that those who are conscientious invest in their physical health by adopting healthy behaviors such as eating more vegetables, walking and flossing (Fry & Debats, 2009). Collectively, this previous work suggests that those with higher perseverance [including high conscientiousness] will maintain consistency of effort required for long-term goals of health (e.g., being physically active and having a healthy dietary behaviors) that may push them through adverse conditions, such as a global pandemic.

The second component of grit is consistency of interest, which refers to the tendency of individuals to maintain a similar array of interests for a long period of time (Duckworth et al., 2007). In a behavior and lifestyle aspect, consistency of interest suggests that someone interested in exercise will most likely always exercise, and/or someone who is interested in eating healthy will most likely always eat healthy. It has been reported that the separate and combined components of grit – perseverance towards a goal and consistency of interest – predict the amount of moderate and vigorous exercise performed among university undergraduate students (Dunston et al., 2020) and adults (Reed et al., 2013). Other research has reported that gritter individuals tend to perform more overall physical activity (Dunston et al., 2020; Hein et al., 2019; Reed, 2014; Reed et al., 2013). Although there is limited literature examining the association between grit and dietary habits/behaviors, this previous work suggests that grit is involved in exercise behaviors and further supports the notion that grit may assist individuals in maintaining healthy lifestyle behaviors during a global pandemic.

The present study aims to explore the relationship between grit and lifestyle behaviors during the COVID-19 pandemic in a sample of adults in the United States. It is hypothesized that individuals with more grit will engage in more physical activity, less sedentary time, and better eating behaviors compared to those with low grit.

2. Methods

2.1. Participants

Data were obtained as part of a larger study investigating the impact of the COVID-19 pandemic on moods and lifestyle and how they change throughout the pandemic in the United States. This larger study is ongoing. The present study utilized a portion of the baseline data when investigating the role of grit on lifestyle behaviors in the early weeks of the pandemic (April 14th–May 3rd, 2020). The target population were male and female adults aged 18 years or older living in the United States. Participants were recruited using a snowball method, via social media (Twitter, Facebook), emails to friends and colleagues, media publications and promotions by the two institutions (names witheld), and via word-of-mouth. Followers on social media and friends and colleagues were encouraged to share the survey. Informed consent was obtained via a cover letter explaining the study with the following statement at the end: "By clicking 'I agree' below, you acknowledge that you have read and understand the description provided, and as such consent to participating in this research study.". The study procedures were approved by the Institutional Review Board at *name withheld* University (approval #20.5.1) and *name withheld* University (approval #1592393-1).

2.2. Survey details

Data in the present study was collected via an electronic survey during the early weeks of the pandemic when lock-downs and confinement were highest (April 14th to May 3rd, 2020). An online platform (Qualtrics, XM, Provo, UT) was used that was accessible by any device with an Internet connection. Data selected for the present study included four sections of: demographics, Grit Scale Short Form (Grit-S), International Physical Activity Questionnaire Short Form (IPAQ-SF), and the Rapid Eating Assessment for Participants Short Form (REAP-S).

2.2.1. Demographics

Information about age, sex, education, living arrangements (e.g., children living at home, urban vs. rural, etc.), and employment were obtained. Questions about mental workload on work and non-work days, smoking status, and any chronic illnesses were also asked.

2.2.2. Grit

The eight-point Grit-S was used to measure trait-level perseverance and consistency of interest (Duckworth et al., 2007; Duckworth & Quinn, 2009). All items were measured on a 5-point Likert scale of 1 (not at all like me) to 5 (very much like me). Representative statements included "Setbacks (delays and obstacles) don't discourage me" and "I am a hard worker". Total points were added up and divided by 8 to obtain a grit score: the maximum score is 5 (extremely gritty) and the lowest score is 1 (not at all gritty). The Grit-S has been shown to have a Cronbach's alpha range of 0.73 to 0.83. The Cronbach's alpha for the current data was 0.80 (Duckworth & Quinn, 2009).

2.2.3. Physical activity and sedentary behavior

The IPAQ-SF is a seven-item scale used to assess self-reported physical activity levels and sedentary time in adults (Craig et al., 2003; Lee et al., 2011). Participants are asked questions about the intensity, duration, and frequency of physical activity and time spent sitting performed over the last seven days. Number of minutes of vigorous, moderate, light activity and sitting time in minutes per week were calculated and reported. Participants were then categorized as inactive (0 min), insufficiently active (0 to <150 min), sufficiently active (150 to <300 min) and highly active (>300 min), and sedentary time was categorized as 0 to <4 h, 4 to <6 h, 6 to <8 h, and > 8 h (Physical Activity Guidelines for Americans. 2nd Edition, 2018).

2.2.4. Dietary behaviors

The REAP-S is a 16-item scale used to evaluate nutritional status and dietary behaviors in adults over a 30-day period (Gans et al., 2006; Segal-Isaacson et al., 2004). The first 13 items assessed frequency of food choices including whole grain, fruit, vegetable, dairy, and meat intake, as well as frequency of processed meats, fried foods, added fats, sweets, and sugar-sweetened beverages intake. Items were scored on a three-point Likert scale of 1 = usually/often, 2 = sometimes, or 3 = rarely/never. Each question was assessed separately, and a total REAP-S score was calculated with higher scores indicating overall healthier diets (Johnston et al., 2018; Segal-Isaacson et al., 2004). The last three items assessed healthy eating behaviors (e.g., how often meals are cooked vs. restaurant food) and the desire of the participants to change their diets in order to be heathier.

2.3. Statistical analyses

2.3.1. Preliminary analyses

All data was downloaded from Qualtrics and transferred to Microsoft Excel. Data was then scored and uploaded to SPSS. If there were any missing data points for any outcome variables, the participant's entire data was removed from the analyses. All variables were evaluated for normality of distribution using a combination of histograms and the Shapiro-Wilks test. None of the variables were normally distributed ($p < 0.05$); exponential, power, arscine and logarithmic transformation techniques were used, however none of the transformations resulted in normally distributed data. Grit and REAP-S scores had histograms that looked normally distributed, while the physical activity scores were positively skewed, and sitting time was negatively skewed. Therefore, large sample theory was employed to use parametric tests (Chernoff, 1956; Lehmann, 2004). To limit the effects of potential outliers, respondents who reported scores >3 standard deviations on either side of the mean for any of the variables reported in this study were eliminated.

2.3.2. Main analysis

Descriptive statistics were computed for demographics, as well as for physical activity, sedentary, and dietary behaviors. A stepwise hierarchical multiple regression was used to explore associations between grit and lifestyle variables (physical activity, sedentary behavior, and dietary habits/behavior) while controlling for demographic variables (age, sex, education status, children at home, employment/student status, chronic medical conditions, and density of urban/rural living location). For a more granular look at grit and lifestyle factors, Analysis of Covariance (ANCOVA) were conducted with sex, education, employment/student status and any chronic diseases used as covariates. Tukey's post hoc analyses were conducted to determine differences between groups when significant findings were observed. A post hoc 4 (physical activity) × 4 (sitting time) Multivariate Analysis of Covariance (MANCOVA) was conducted to determine if there was a significant difference in grit between groups. All analyses were completed using SPSS v26.0 (IBM Corp. Released 2016, IBM SPSS Statistics for Windows: Armonk, NY), with a level of significance of $p < 0.05$.

3. Results

Of the 1557 people who initiated the survey, 669 were omitted due to missing data points ($n = 403$), not living in the United States ($n = 166$), or were outliers ($n = 100$); a total of $n = 888$ was used for the present study. Participant characteristics are presented in Table 1.

The stepwise multiple regression analyses for associations between grit and lifestyle factors are shown in in Table 2. In the first step of the model, demographic characteristics explained 8.9% of the adjusted variance (unadjusted $R^2 = 0.089$, $F(9, 878) = 9.588$, $p < 0.001$). Participants who were older, more educated, had children living at home, were students, were employed, and had no chronic diseases reported

Table 1
Participant characteristics (n = 888).

Variable	Mean ± SD	Grit mean ± SD
Grit	3.48 ± 0.62	
Age (years)	34.76 ± 14.02	
Sex:		
Male	26.6%	3.50 ± 0.64
Female	73.3%	3.47 ± 0.61
Not-defined	0.10%	1.75
Education:		
Some high school	0.20%	2.81 ± 0.97
High school diploma/GED	2.4%	3.33 ± 0.71
Education beyond high school	13.0%	3.19 ± 0.70
Associates degree	6.0%	3.58 ± 0.46
Bachelor's degree	37.9%	3.44 ± 0.63
Master's degree	27.2%	3.57 ± 0.56
Doctorate degree	13.3%	3.48 ± 0.62
Children living at home		
Yes	27.4%	3.59 ± 0.54
No	72.6%	3.43 ± 0.64
Living situation:		
Big city	14.6%	3.38 ± 0.73
Small city	20.6%	3.52 ± 0.61
Suburb	21.6%	3.48 ± 0.57
Small town	25.4%	3.46 ± 0.59
Rural area	17.9%	3.53 ± 0.64
Current employment status (during COVID-19 pandemic):[a]		
Employed full-time	50.6%	3.51 ± 0.61
Furloughed/laid off	3.4%	3.46 ± 0.26
Employed part-time	7.1%	3.41 ± 0.64
Self-employed	2.8%	3.41 ± 0.79
Full-time student	18.7%	3.45 ± 0.58
Part-time student	0.70%	3.32 ± 0.64
Unemployed	11.8%	3.24 ± 0.74
Retired	4.8%	3.53 ± 0.53
Chronic medical condition		
Yes	31.5%	3.40 ± 0.61
No	68.5%	3.51 ± 0.62
Smoker		
Yes	7.0%	3.26 ± 0.70
No	93.0%	3.49 ± 0.61
Intensity of mental workload on work/school days	91.97 ± 86.03	
Intensity of mental work on non-work/school days	22.48 ± 40.93	
Number of hours of work/week	32.19 ± 21.00	

(continued on next page)

Table 1 (*continued*)

Variable	Mean ± SD	Grit mean ± SD
Physical activity & sedentary behavior (minutes/week):		
Vigorous physical activity	248.23 ± 442.34	
Moderate physical activity	240.84 ± 495.48	
Light physical activity	377.00 ± 603.06	
Total time spent sitting (weekdays only)	2848.88 ± 1361.72	
Typical eating habits		
Shop and cook	94.4%	3.48 ± 0.62
Eating at restaurant/take-out	5.6%	3.35 ± 0.65
Feel well enough to cook		
Yes	94.9%	3.50 ± 0.61
No	5.1%	3.04 ± 0.63
How willing are you to change eating habits? (1 = very willing; 5 = not at all willing)	1.86 ± 0.90	

Continuous variables are mean ± standard deviation; categorical variables are percent.
Grit scores presented for categorical variables only.
[a] n = 940 since participants were allowed to mark multiple categories.

higher grit scores. The second step of the model included lifestyle variables (smoking, mental work on work and non-work days, physical activity, sedentary behavior, and dietary habits and behaviors) and explained an additional 8% of the adjusted variance (unadjusted $R^2 = 0.182$, $F(20, 867) = 9.657$, $p < 0.001$). Participants who reported higher grit also reported participating in more vigorous physical activity, less sitting time, and better dietary habits and behaviors. Those who reported higher grit also reported more intense mental work on work/school days.

Findings from the ANCOVAs are reported in Tables 3 and 4. The general trend observed was that those with higher grit tended to have healthier lifestyle behaviors. For example, those who reported >300 min per week of physical activity reported higher grit than those who were physically active for <300 min per week, and those who reported sitting for >8 h per day reported lower grit than those who reported sitting <6 h per day (Table 3). A post hoc MANCOVA was performed to assess physical activity behavior by sedentary behavior; none of the results were significant. Regarding dietary habits, those who reported positive eating habits such as regularly eating breakfast, rarely eating takeout, consuming more than 2 servings per day of starches, fruits, and vegetables, and consuming less processed foods, fried foods, high fat snacks, sweets, and sugar-sweetened beverages also reported higher grit (Table 4).

4. Discussion

The present study sought to determine the relationship between personality traits encompassed in 'grit' and lifestyle behaviors among adults in the United States during the early lockdown stages of the COVID-19 pandemic [April 14th–May 3rd, 2020]. In line with our hypotheses, our main findings were that individuals with more grit were engaged in higher levels of vigorous physical activity, higher durations of total physical activity, lower levels of sedentary [sitting] time, and had better dietary habits/behaviors compared to those with less grit during the early stages of quarantine.

In Duckworth's early work on grit, her and her colleagues reported that gritty individuals are generally older, have more education, and change jobs less often in a lifetime than those with low grit (Duckworth et al., 2007). Our findings are comparable, suggesting that those with higher grit are more likely to be older, more educated, and more likely be employed during the COVID-19 pandemic. For the present cohort this may simply be circumstantial as many jobs lost in the early part of the COVID-19 pandemic were among young people with high school degrees and some college (Montenovo et al., 2020); our data seem to be in line with this national trend. We also found that those who reported chronic medical conditions reported having lower grit. While we are unaware of any literature that examines differences in grit between those who report chronic diseases compared to those who do not, grit has been associated with better physical and mental health (Sharkey et al., 2017).

Table 2
Step-wise multiple regression analyses for associations between grit and lifestyle factors (controlling for demographic variables) ($n = 888$).

Variable	B [95% CI]	t	*p*-value
Step 1 ($R^2 = 0.089$)			
Age	0.143 [0.003, 0.010]	3.653	<0.001
Sex (ref: male)	−0.002 [−0.091, 0.087]	−0.046	0.963
Education status (ref: less educated)	0.161 [0.044, 0.112]	4.563	<0.001
Children at home (ref: children at home)	−0.076 [−0.200, −0.011]	−2.184	0.029
Student (ref: student)	−0.116 [−0.256, −0.038]	−2.655	0.008
Employment status (ref: employed)	−0.161 [−0.387, −0.110]	−3.530	<0.000
Chronic medical conditions (ref: chronic med cond'n)	0.111 [0.059, 0.236]	3.261	0.001
Dense vs. less dense populated area (ref: dense)	0.027 [−0.018, 0.043]	0.810	0.418
Step 2 ($R^2 = 0.182$; $\Delta R^2 = 9.3$)			
Age	0.110 [0.002, 0.008]	2.915	0.004
Sex (ref: male)	−0.013 [−0.105, 0.068]	−0.421	0.674
Education status (ref: less educated)	0.107 [0.019, 0.085]	3.068	0.002
Children at home (ref: children at home)	−0.048 [−0.159, 0.024]	−1.440	0.150
Student (ref: student)	−0.084 [−0.223, 0.009]	−1.814	0.070
Employment status (ref: employed)	−0.123 [−0.332, −0.049]	−2.635	0.009
Chronic medical conditions (ref: chronic med cond'n)	0.069 [0.006, 0.179]	2.104	0.036
Dense vs. less dense populated area (ref: Dense)	0.014 [−0.023, 0.036]	0.422	0.673
Smoking (ref: smoker)	0.027 [−0.086, 0.217]	0.849	0.396
Intensity of mental work on work/school days	0.107 [0.000, 0.001]	2.318	0.021
Intensity of mental work on non-work/non-school days	0.023 [−0.001, 0.001]	0.669	0.503
Number of hours of work/week	0.034 [−0.002, 0.004]	0.704	0.481
Vigorous physical activity (mins/week)	0.077 [0.000, 0.000]	2.239	0.025
Moderate physical activity (mins/week)	−0.011 [0.000, 0.000]	−0.311	0.756
Light physical activity (mins/week)	0.025 [0.000, 0.000]	0.774	0.439
Total time spent sitting (mins/week)	−0.120 [0.000, 0.000]	−3.610	<0.001
Total REAP-S score	0.141 [0.011, 0.032]	4.152	<0.001
Cook food vs eat out (ref: cook food)	0.010 [−0.139, 0.194]	0.325	0.746
Usually feel well enough to cook (ref: yes)	−0.089 [−0.426, −0.072]	−2.757	0.006
Willingness to change eating habits (Ref: most willing)	−0.096 [−0.110, −0.023]	−2.994	0.003

REAP-S = rapid eating assessment for participants – short form.

Table 3
ANCOVA for grit (mean ± SD (n)) and physical activity/sedentary behavior.

Physical activity	0 min (1)	0 to < 150 min (2)	150 to < 300 min (3)	300+ min (4)	p-Value	F-statistic	Post hoc
	3.37 ± 0.62 (*n* = 155)	3.35 ± 0.75 (n = 100)	3.37 ± 0.59 (*n* = 116)	3.56 ± 0.58 (*n* = 517)	<0.001	9.725	4 > 3, 2, 1
Sedentary behavior	0 to < 4 h (1)	4 to < 6 h (2)	6 to < 8 h (3)	>8 h (4)			
	3.58 ± 0.59 (*n* = 152)	3.54 ± 0.57 (*n* = 203)	3.50 ± 0.63 (*n* = 156)	3.39 ± 0.64 (*n* = 378)	<0.001	6.784	4 < 1, 2

Post hoc MANCOVA: physical activity by sedentary behavior						
Physical activity	PA 0 min	PA 0 to < 150 min	PA 150 to < 300 min	PA 300+ min	p-Value	F-statistic
Sit 0 to < 4 h	3.28 ± 0.68 (n = 15)	3.44 ± 0.71 (*n* = 12)	3.54 ± 0.69 (*n* = 17)	3.63 ± 0.55 (*n* = 117)	0.591	0.827
Sit 4 to < 6 h	3.43 ± 0.52 (n = 29)	3.40 ± 0.77 (*n* = 24)	3.40 ± 0.42 (*n* = 32)	3.61 ± 0.56 (*n* = 120)		
Sit 6 to < 8 h	3.14 ± 0.62 (*n* = 18)	3.48 ± 0.82 (*n* = 21)	3.35 ± 0.53 (n = 28)	3.61 ± 0.59 (*n* = 98)		
Sit > 8 h	3.40 ± 0.64 (n = 98)	3.27 ± 0.73 (*n* = 49)	3.30 ± 0.66 (*n* = 46)	3.46 ± 0.61 (*n* = 164)		

ANCOVA = analysis of covariance; MANCOVA = multivariate analysis of covariance; PA = physical activity.
All analyses controlled for sex, education, employment/student status, and chronic diseases. Units of physical activity are minutes (mins) per week. Units of sitting are hours (h) per day.

The multiple regression analyses revealed that grittier individuals performed more vigorous physical activity, spent less time being sedentary, and had healthier dietary habits/behaviors. Our findings regarding vigorous physical activity agrees with the work by Dunston and colleagues who reported that grit is associated with vigorous physical activity in non-pandemic times (Dunston et al., 2020). Our results also revealed that over 71% of our population met the physical activity guidelines (Physical Activity Guidelines for Americans. 2nd Edition, 2018), and those who reported being very physically active (>300 min per week) were the grittiest individuals. Pre-COVID-19 data from the National Health and Nutrition Examination Survey (NHANES) reported that 62% of persons living in the United States met the physical activity guidelines, participating in 74 min/week of vigorous and 325 min/week of moderate physical activity (Ussery et al., 2018). Although self-report data has limitations, both the present study and the NHANES data set used subjective physical activity recall and are therefore comparable; moderate and vigorous physical activity were higher during the COVID-19-induced quarantine [compared to pre-COVID-19-induced quarantine]. It is possible that during quarantine people used their increased discretionary time to become more physically active, and more so among those with higher grit. It would be interesting to analyze NHANES physical activity data by grit category; it is possible that individuals with more grit are more likely to meet the physical activity guidelines.

Regarding sedentary behavior, the present cohort reported sitting approximately 9.5 h per day; the NHANES data from 2016 reported that the average person living in the United States sat for approximately 7.7 h per day (Ussery et al., 2018). The sitting time difference may be due to changes in job function during the COVID-19 pandemic as most work went remote. However, it should be noted that those who reported sitting >8 h per day also reported the lowest grit scores. A post hoc MANCOVA was conducted to assess physical activity by sedentary time; although not significant the results showed a trend of those reporting >300 min MVPA per week also reported higher grit scores regardless of how much time they spent sitting. For example, those who reported sitting for <4 h per day but performed 300+ minutes of MVPA per week had higher mean grit scores than those who reported 150–300 min of MVPA per week (3.63 ± 0.55 vs. 3.54 ± 0.69). The same is true for the group that sat for >8 h (3.46 ± 0.61 vs. 3.30 ± 0.66). Although there is a large difference in the group sizes, it may be hypothesized that even if participants had to be seated for extended periods of time due to work-related constraints during the COVID-19 pandemic (e.g. working a white-collar job from home), those with higher grit tried to make up for the increased sedentary behavior by exercising more throughout the week. This hypothesis supports the "invest-and-accrue" model of conscientiousness (Hill & Jackson, 2016) – gritty individuals invest in their health by being more physically active.

Regarding dietary habits/behaviors, those with higher grit reported

Table 4
ANCOVA for grit (mean ± SD (n)) and individual eating habits.

Variable	Usually/often (U)	Sometimes (S)	Rarely/never (R)	p-Value	F-statistic	Post hoc
Breakfast skipped	3.36 ± 0.64 (*n* = 241)	3.41 ± 0.65 (*n* = 188)	3.56 ± 0.58 (*n* = 458)	0.002	6.438	R > S, U
Frequency of eating takeout	3.36 ± 0.76 (*n* = 45)	3.37 ± 0.61 (*n* = 170)	3.51 ± 0.61 (*n* = 673)	0.021	3.877	R > S
Eat < 2 servings of starches/day	3.38 ± 0.68 (*n* = 138)	3.41 ± 0.63 (*n* = 305)	3.56 ± 0.58 (*n* = 445)	0.003	5.916	R > S, U
Eat < 2 servings of fruits/day	3.29 ± 0.67 (*n* = 198)	3.49 ± 0.60 (*n* = 358)	3.57 ± 0.59 (n = 332)	<0.001	12.846	R > U S > U
Eat < 2 servings of vegetables/day	3.35 ± 0.64 (*n* = 135)	3.45 ± 0.62 (*n* = 332)	3.54 ± 0.60 (*n* = 421)	0.016	4.165	R > U
Eat/drink < 2 servings of dairy/day	3. 43 ± 0.63 (*n* = 195)	3.46 ± 0.61 (*n* = 300)	3.51 ± 0.62 (*n* = 393)	0.724	0.323	R > U S > U
Eat > 8 oz of meat/day	3.46 ± 0.64 (*n* = 237)	3.46 ± 0.61 (*n* = 288)	3.50 ± 0.62 (*n* = 363)	0.622	0.476	
Eat regular processed foods	3.13 ± 0.70 (*n* = 62)	3.46 ± 0.57 (*n* = 265)	3.52 ± 0.62 (*n* = 551)	<0.001	10.169	R > U
Eat fried foods	3.18 ± 0.72 (*n* = 44)	3.42 ± 0.61 (*n* = 319)	3.54 ± 0.61 (*n* = 525)	0.002	6.170	R > S, U S > U
Eat high fat snacks	3.32 ± 0.70 (*n* = 143)	3.49 ± 0.57 (*n* = 447)	3.54 ± 0.63 (*n* = 298)	0.003	5.914	R > U S > U
Add butter or oil to foods	3.39 ± 0.63 (*n* = 257)	3.48 ± 0.59 (*n* = 337)	3.55 ± 0.64 (*n* = 294)	0.061	2.814	
Eat sweets > 2×/day	3.27 ± 0.67 (*n* = 140)	3.49 ± 0.57 (*n* = 379)	3.55 ± 0.63 (*n* = 369)	<0.001	11.250	R > U S > U
Drink 16 oz or more soda/day	3.15 ± 0.73 (*n* = 59)	3.31 ± 0.71 (*n* = 99)	3.53 ± 0.59 (*n* = 730)	<0.001	11.087	R > S, U

ANCOVA = analysis of variance.
All analyses controlled for sex, education, employment/student status, and chronic diseases.

better eating habits (individual food choices and total REAP-S score), being more willing to cook at home and more willing to change their diets to eat healthier. Although we did not directly measure interest in healthy lifestyles, our results suggest that those who are grittier may have a greater interest in healthier diets, explaining why they report eating healthier. The conscientiousness and self-control aspects of grit may also contribute to healthier dietary habits and behaviors. When looking at individual components on the REAP-S, individuals reporting higher grit reported eating breakfast regularly, refraining from eating take-out, processed foods, fried foods, fatty snacks, sweets and soda, and consuming more fruits, vegetables and starches when compared to those reporting lower grit. No differences were found based on grit for meat or dairy consumption, perhaps due to conflicting information about benefits of meat-based protein and dairy (Chan et al., 2001; Ebringer et al., 2008; McAfee et al., 2010). Although we did not measure emotional eating in the present study, emotions such as anxiety, stress and depression contribute to emotional hunger and less ability to control food intake (Konttinen et al., 2010; Litwin et al., 2017). The isolation, lack of stimulation, and boredom of quarantine likely had less of an effect on changes in food routines and behaviors among those with high vs. low grit; resilience to maintain a normal lifestyle and be healthy overall is a beneficial trait of a gritty person (Duckworth et al., 2007). Further, those who were grittier were also more likely to be employed and may have been less affected by the COVID-19-related job losses, and therefore left them greater resources to access higher quality foods.

An interesting finding that arose from this study analyses is that gritter individuals reported more mental work on work/school days, but not on non-work/non-school days. Potential explanations for increased mental work on work/school days include: 1) grittier individuals may have had greater work day related obligations during the COVID-19 pandemic; and/or 2) those who are grittier were more educated and held white collar jobs that required greater mental work. While we controlled for education and employment status in our analyses, we cannot pinpoint why grittier individuals reported greater work-day mental workload. A potential rationale for no association between grit and mental work on non-work/non-school days is that gritter persons are not necessarily willing to pursue intellectual work on days they are not working; they may prefer a good work-life balance.

The present study has several limitations, including the cross-sectional nature of the data. However, this is an on-going study and therefore more information about the consistency of lifestyle behaviors based on grit will be learned through examination of the longitudinal data. Although the selected surveys are validated, there may have been some social bias associated as all data were based as retroactive self-report. Also, our sample was highly educated and therefore healthier lifestyle behaviors may have been expected compared to the general public. Lastly, the COVID-19 pandemic is fast moving and physical distancing rules and stay-at-home orders varied from state-to-state and region-to-region and are time-sensitive. These factors were not measured and may have played a role in the lifestyle differences reported in this study.

The present findings suggest that grit, encompassing personality traits of resilience, ambition, conscientiousness, endurance, and self-control, may help individuals avoid negative lifestyle behaviors that can arise during stressful or negative life events such as were encountered during the first three weeks of COVID-19-induced quarantine. Maintaining or initiating positive lifestyle behaviors during the COVID-19 pandemic is an urgent global health need. Poor lifestyle behaviors may lead to increased morbidity and mortality from COVID-19 (short-term) (Calder et al., 2020; Nieman & Wentz, 2019), as well as increased risk for numerous chronic diseases (long-term) (Lavie et al., 2019; Ryan et al., 2015). The present findings provide important insight regarding individual differences in personality that may predict the health and well-being of persons during extended quarantine that can contribute to the development of effective methods of health promotion. As the COVID-19 pandemic is on-going, our findings should be confirmed and investigated longitudinally; that is, are lifestyle behaviors changing as the quarantine continues and what role does personality play in these changes.

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Pre-registration

This study was not pre-registered.

Data

Data for this study can be accessed through the journal. Description of all analyses has been reported in the manuscript.

CRediT authorship contribution statement

J.O. Totosy de Zepetnek: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. **J. Martin:** Conceptualization, Data curation, Investigation, Methodology, Writing – review & editing. **N. Cortes:** Conceptualization, Data curation, Investigation, Methodology, Writing – review & editing. **S. Caswell:** Conceptualization, Data curation, Investigation, Methodology, Writing – review & editing. **A. Boolani:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors have no conflicts of interest to report.

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