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# Positive Psychological Factors in Health and Social Care Workers in the Context of COVID-19

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# Chapter One: Systematic Review

**Posttraumatic Growth amongst Health and Social Care Workers During the COVID-19 Pandemic: A Systematic Review.**

Chapter word count: 6219 excluding abstract, tables, figures, references, and appendices.

Prepared in accordance with the author requirements for British Journal of Health Psychology; https://bpspsychub.onlinelibrary.wiley.com/hub/journal/20448287/homepage/forauthors.html

# Abstract

**Purpose:** Posttraumatic Growth (PTG) is defined as positive psychological changes following exposure to and struggling with traumatic events or major adverse crises. Historically, research in various populations has suggested a range of positive outcomes associated with PTG. This is the first review to examine PTG amongst Health and Social Care Workers (HSCWs) during the COVID-19 pandemic with the aims of exploring the levels of PTG amongst HSCWs in the context of COVID-19, along with its associated and influencing factors.

**Methods:** A systematic search was completed in February 2023 in the following databases: CINAHL, EMBASE, Medline, PsycINFO, PubMed and SCOPUS. A total of 39 studies were included, the majority of which were cross-sectional in design. The included studies were quality appraised using the Mixed Methods Appraisal Tool, and a narrative approach to synthesis was adopted.

**Results:** Whilst levels of PTG varied greatly across the included studies, the synthesis revealed three overarching categories of factors associated with PTG, namely individual factors, interpersonal factors, and work related factors. The low number of papers in which temporal precedence could be established meant that the review was limited in its ability to be able to accurately identify the full range of factors which likely influence PTG within this population.

**Conclusions:** The findings were largely in keeping with previous research in this area, highlighting the need for both individual and organizational factors to be drawn upon in order to promote the PTG of HSCWs in response to the current and any future pandemics. Future research addressing concerns about the measurement of PTG, and temporal precedence will further elucidate the factors which promote PTG for HSCWs.



**Keywords:** Posttraumatic growth, Health and Social Care Workers, COVID-19, review, PTG.

# Introduction

Coronavirus disease 2019 (COVID-19) was declared a pandemic by the World Health Organisation (WHO) on 12th March 2020. As of the 18th June 2023, there have been over 768 million confirmed cases of COVID-19 and a cumulative death toll of over 6.9 million globally (WHO, 2023). The pandemic has had an extensive impact on mental health worldwide and can be considered to be an event of a traumatic nature. One group that has been particularly adversely affected is Health and Social Care Workers (HSCWs). It has been well documented that COVID-19 is associated with negative post-traumatic stress symptoms and other psychological problems in HSCWs (De Kock et al. 2021; Giorgi et al., 2020; Luo et al., 2020; Pappa et al., 2020). A meta-analysis by Batra et al. (2020), which included 65 studies with a population totalling almost 80,000 healthcare workers, detailed a prevalence of 11.4%, 27.8%, 31.8%, 34.4%, 37.4%, 40.3% and 46.1% for post-traumatic stress disorder (PTSD), insomnia, depression, anxiety, burnout, stress, and psychological stress, respectively. Whilst initially there was much emphasis on documenting these negative impacts of the COVID-19 pandemic, attention has slowly shifted towards exploring the possible positive consequences of this traumatic time period (Finstad et al., 2021).

One proposed positive impact is Posttraumatic Growth (PTG). This term was first coined in the mid-1990s by psychologists Tedeschi and Calhoun (Tedeschi & Calhoun, 1996). PTG has been conceptually defined as positive psychological changes which have occurred in the context of struggling with traumatic life events or major life crises (Calhoun & Tedeschi, 1999). It is not a return to baseline functioning prior to the traumatic event; rather there has been development in at least some areas which surpasses prior functioning (Tedeschi & Calhoun, 2004). In the most common theory, PTG is thought to be manifested across five domains: increased sense of personal strength, changed priorities, increased appreciation for life, more meaningful interpersonal relationships, and a richer existential and spiritual life (Tedeschi & Calhoun, 2004). The “personal strength” domain incorporates positive changes in how individuals may perceive their abilities to adapt to and overcome challenges. The “changed priorities” domain relates to when individuals following trauma may come to recognise the opportunities around them or they may establish a different, valued path in life, e.g., pursuing a new vocation. The “appreciation for life” domain can be considered to reflect change in what an individual may deem as their priorities in life. Whereas the “more meaningful interpersonal relationships” domain may reflect changes in how close individuals may feel toward others and a newfound level of appreciation for friends and family. Finally, the “existential and spiritual life” domain relates to having stronger or more meaningful religious beliefs or spirituality. A review by Weiss and Berger (2010) has concluded that PTG is a universal phenomenon, with PTG being noted to occur in people facing a diverse range of traumatic events including (but not limited to) various serious illnesses of the self or close others, bereavements, automobile accidents, sexual assaults, refugee experiences, and being taken hostage (Tedeschi & Calhoun, 2004).

Tedeschi and Calhoun (2004) have indicated that whilst exposure to a trauma or highly challenging circumstance is a necessary pre-requisite to the development of PTG, exposure is not sufficient to produce PTG in and of itself; rather, traumatic events can pose such a

threat to an individual's core values and beliefs, that it leads to a shattering of these. This process of PTG is largely based on the work of Janoff-Bulman (1992) which describes the idea that people develop an "assumptive world" which is culturally informed and individualized. When these strongly held beliefs about the world and self are called into question by traumatic experiences, affected individuals in order to regain psychological equilibrium, are forced to revise their system of beliefs. A meta-analysis by Shakespeare-Finch and Lurie-Beck (2014) described the relationship between PTG and PTSD as best classified as an inverted U, such that a reasonable amount of distress may trigger PTG, but that at very high levels PTG decreases or may be unable to be attained. Attempts to cognitively process and rebuild the assumptive world which takes the trauma into account, along with social support and self-disclosure, are what is thought to result in the changed philosophical and psychological values and beliefs as well changes as in one's approach to life (Tedeschi & Moore, 2021). Despite the above noted changes, the trauma itself continues to be a distressing event.

Findings on the relationship between PTG and health outcomes have been mixed. PTG has been found to be associated with improved functioning and resilience to subsequent traumatic events amongst US war veterans (Pietrzak et al., 2021; Tsai et al., 2015) and a meta-analysis by Helgeson et al. (2006) has shown that PTG is related to lower depression and increased wellbeing in adult populations. Helgeson et al. (2006) also found PTG to be positively related to wellbeing, self-esteem, and life satisfaction. Conversely, a review by Long et al. (2021) reported PTG not to be associated with anxiety or depression whilst Casellas-Grau et al. (2017) from their review, reported a lack of consensus on whether PTG has a relationship with anxiety and depression. Despite a lack of clarity surrounding the relationship between PTG and broader mental health outcomes, the importance of promoting PTG at the organisational level has been highlighted (Olson et al., 2020). According to these authors, it may be possible to reduce the negative impact of future psychological traumas, and for stronger health care organisations along with more resilient staff teams to be created. Outcomes found to be related to PTG in the work context include more resilient career identities, career proactivity, a sense of accomplishment and meaningfulness in work, and a better understanding of the work, factors which are likely to have an impact on staff retention (Brooks et al., 2018; Vough & Caza. 2017). It is not surprising that a budding field of research is exploring the possible positive consequences for HSCWs during the COVID-19 pandemic (Finstad et al., 2021).

To the authors' knowledge, no review to date has examined levels of PTG amongst HSCWs during the COVID-19 pandemic and explored its associated and influencing factors within this population. By doing so, the present review may inform targets for intervention in promoting PTG within this population. PTG has been suggested to likely have benefits at both the individual e.g., increased wellbeing, and the organisational level e.g., more resilient staff teams. The importance of creating caring climates within organisations which promote the mental health of HSCWs has been deemed a necessity for ensuring patient safety (De Kock et al., 2022), especially as the negative effects of HSCW poor mental health on quality of care has been well documented (Tawfik et al., 2019). Given that the probability of another pandemic occurring has been predicted to increase threefold in the coming decades (Marani

et al., 2021), promoting PTG amongst HSCWs is a worthwhile endeavour for the public health response to COVID-19 and future pandemics.

### Aims and Review Questions

The aim of the current systematic review was to assess the level of PTG amongst HSCWs in the context of the COVID-19 pandemic, and to explore its associated and influencing factors, thereby possibly enabling a basis for targeted interventions for HSCWs to be provided.

This review aimed to address the following research questions:

1. What was the level of posttraumatic growth amongst HSCWs during the COVID-19 pandemic?
2. What demographic and psychosocial factors were associated with posttraumatic growth amongst HSCWs during the COVID-19 pandemic?
3. What factors predicted the development of posttraumatic growth amongst HSCWs during the COVID-19 pandemic?

## Method

This systematic review was conducted in accordance with The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Page et al., 2021) and registered on PROSPERO (CRD42023398617).

### Search Strategy

The initial search strategy was developed through collaboration with a specialist librarian for Medline (OVID) using a modified PECOS framework. This was then adapted for other databases as appropriate. A systematic search was conducted on 23/02/2023 using the following databases: CINAHL (EBSCOhost), EMBASE (OVID), Medline (OVID), PsycINFO (OVID), PubMed (EBSCOhost) and SCOPUS, with date parameters set from the onset of COVID-19 (March 2020) to the date of the search. Forward and backward citation of included studies was conducted as well as searching reference lists. A copy of each search strategy is available in Appendix 1.1.

### Eligibility Criteria

Criteria for inclusion included: 1) Only studies which involved the target population – HSCWs, the target topic - PTG, and the target timeframe – during the COVID-19 pandemic; 2) Studies written in English and published in a peer-reviewed journal, with the full text available; 3) Observational, mixed methods and experimental studies including cross-sectional and longitudinal designs incorporating quantitative data; and 4) Studies which used a validated measure to assess PTG. Studies were excluded if they were about the general population. If studies had mixed population samples, these were only included if the relevant data for the HSCWs subgroup had been reported separately. Articles written in languages other than English and using other study designs or qualitative data only were also excluded. Finally, editorials, non-peer reviewed articles, literature reviews, systematic

reviews, meta-analyses, conference abstracts, posters, and theses or dissertations were also excluded.

### Screening Stage

Upon transfer to EndNote, duplicates were manually removed by the primary reviewer. Screening was undertaken using a two-stage process. Firstly, title and abstract screening for all articles was completed by the primary reviewer to determine eligibility. Then for potentially eligible papers, full texts were obtained and examined against the inclusion criteria by the primary reviewer. In order to check reliability, 25% of the papers at both stages were independently screened by a second reviewer. Any discrepancies between reviewers were resolved through discussion.

### Data Extraction

Data extraction was manually completed by the primary reviewer using a template specifically designed for this review which captured a range of information e.g., study design, study population, PTG measurement tool, mean PTG level, and factors associated with PTG. In order to verify the accuracy of data extraction, the second reviewer examined the extracted data of N =10 of the included studies. It was beyond the scope of this review for authors to be contacted for additional or missing data, synthesis was therefore restricted to only the data included in the published studies.

### Quality Appraisal

Given the divergent range of study designs incorporated in this review, it was decided to use the Mixed Methods Appraisal Tool (MMAT) by Hong et al. (2018) to assess the quality of all included studies. The second reviewer also used this tool to independently examine the quality of (N =10) included papers. The quality appraisal assessment was not utilized to exclude eligible studies; rather the results were considered such that it could be determined which studies provided the most robust evidence, and therefore, from which stronger conclusions could be drawn.

### Data Synthesis

A narrative approach to synthesis using recommended guidelines (Popay et al., 2006) was adopted due to the heterogenous nature of the included studies. It involved the tabulation of data, grouping, use of textual descriptions and the exploration of relationships within and between studies. Results were then synthesized and grouped in line with the review questions which included the level of PTG, and its associated and influencing factors amongst HSCWs in the context of COVID-19.

## Results

A total of 3984 studies were identified through the database searching. N = 2314 duplicates were removed, with the remaining 1670 records then screened by title and abstract for relevance. There was substantial inter-rater reliability agreement at title and abstract stage (Cohen's kappa = 0.793, 70% agreement rate) which increased to near perfect agreement following discussion (Cohen's kappa = 0.964, 95% agreement rate), with Cohen's kappa being

interpreted in line with the values suggested by McHugh (2012). A total of fifty one papers were then read in full and compared against the inclusion criteria. Forwards and backwards citation and reference lists searching were then completed for the thirty six eligible studies with an additional three studies being identified, read in full, and found to be eligible for inclusion. There was near perfect inter-rater reliability agreement at full text stage (Cohen's kappa = 0.901). The agreement rate between reviewers at full text stage was 95%. The total number of studies included for quality appraisal and data extraction was thirty nine. See Figure 1.1 for an overview.

**Study Characteristics**

Table 1.1 denotes the characteristics of the thirty nine included studies which were published between 2021 and 2023. The total sample size across all studies was 32,578. It is possible however that the studies by Kalaitzaki and Rovithis (2021) and Kalaitzaki et al. (2022) shared participants, and as such, their results may not be independent of each other. The largest sample size was 12,596 (Chen et al., 2021) and the smallest sample size was 32 (Fernández-ávalos et al., 2022). These studies included a range of frontline and non-frontline HSCWs including nurses, intellectual disability workers, dental personnel, therapists and counsellors, medical rescuers, and radiation medicine staff. The majority of studies (N = 28) were cross sectional in design, with a further six prospective cohort designs, two experimental designs, two mixed method designs, and a single two-study (prospective cohort and cross sectional design) paper. The majority of studies (N = 15) were conducted in China, the USA (N =3), and Turkey (N= 3). The remaining eighteen studies were conducted in Australia, Italy, the UK, Israel, Spain, Portugal, Korea, Greece, Saudi Arabia, Kosovo, Canada, France, Pakistan, and Palestine.

**Quality Appraisal**

A summary of the quality appraisal ratings as assessed by the MMAT can be found in table 1.2. Agreement rate between reviewers on quality ratings was 78.5% initially, with this increasing to 86% following discussion. Overall, the ratings were found to be moderate. Only two (Han et al., 2022; Yan et al., 2022) of the thirty nine included studies received the highest quality rating. A broad pattern of unclear reporting across the studies was noted, with thirty one studies receiving at least one "can't tell" rating. It was not clear for the majority of cross sectional studies whether they had representative samples (N = 22) or low risk of non-response bias (N =16).

**PTG Measurement and Level**

Information on the outcome of PTG for each included study is documented in table 1.3. Twenty four studies used the Posttraumatic Growth Inventory (PTGI) by Tedeschi and Calhoun (1996) or a foreign language version of this measure. The PTGI consists of 21 items, scored on a Likert scale of 0 (did not experience this change) to 5 (experienced this change to a very great degree), with scores ranging from 0 – 105. Higher scores indicate greater PTG. There was a very large range in PTG scores across these papers, with a 53.29-point difference between the lowest mean PTGI value (mean = 43.80; SD = 14.65; Yim & Kim, 2022) and the highest (mean = 97.09; SD = 18.47; Jiang et al., 2022). Of the twenty four

studies, six used the simplified Chinese version of the PTGI by Wang et al. (2011). This version consists of 20 rather than 21 items, scored on a Likert scale of 0 (did not experience this change) to 5 (experienced this change to a very great degree), with scores ranging from 0 – 100. There was a fairly large range in PTG scores across these papers, with a 20.04-point difference between the lowest mean PTGI value (mean = 50.49; SD = 24.02; Lai et al., 2021) and the highest (mean = 70.53; SD = 17.26; Cui et al., 2021).

Twelve studies used the Posttraumatic Growth Inventory – Short Form (PTGI-SF) by Cann et al. (2010) or a foreign language version of this measure. The PTGI-SF consists of 10 items, scored on a Likert scale of 0 (did not experience this change) to 5 (experienced this change to a very great degree), with scores ranging from 0 -50. There was a moderate range in PTG scores across these papers, with a 16.34-point difference between the lowest mean PTGI-SF value (mean = 17.83; SD = 10.30; Uziel et al., 2021) and the highest (mean = 34.17; SD = 3.4; Labban et al., 2021).

Three studies used the Posttraumatic Growth Inventory -Expanded (PTGI-X) by Tedeschi et al. (2017) or a foreign language version of this measure. The PTGI-X consists of 25 items, scored on a Likert scale of 0 (did not experience this change) to 5 (experienced this change to a very great degree), with scores ranging from 0 – 125. Han et al. (2022) reported lowest mean PTGI-X value (mean = 60.15; SD = 24.59) and Zhang et al. (2022) the highest (mean = 76.74; SD = 27.13).

Two studies (Carole et al., 2022; Feingold et al., 2022) did not report a total mean PTG score at any timepoint; rather in these studies, they reported the means of the PTG dimensions. One study (Pfeiffer et al., 2023) reported the median and interquartile range of PTG rather than the mean and standard deviation. Twelve studies reported PTG mean scores which appear to have been computed by using mean item scores, hence values can range from 0 to 5. Aafjes-van Doorn et al. (2022) reported the lowest level of PTG recorded in this manner (mean = 1.24; SD = 0.83) and Moreno-Jimenez et al. (2021) reported the highest (mean = 4.11; SD = 0.84).

The included studies differed widely in how they classified levels of PTG amongst this population. As such, an internally coherent system was developed, see appendix 1.2 for further details. Using this system, levels of PTG were found to vary greatly across the studies, see table 1.3. High levels of PTG were found in eight studies. Moderate to high levels were found in four studies. PTG of a moderate level was found in eight studies, with five studies reporting fair to moderate levels. Fair levels of PTG were reported in four studies. Low levels of PTG were reported by ten studies. Overall, the highest levels of PTG were found in studies conducted in China.

***Figure 1.1*** *PRISMA Flow Diagram (Page et al. 2020)*

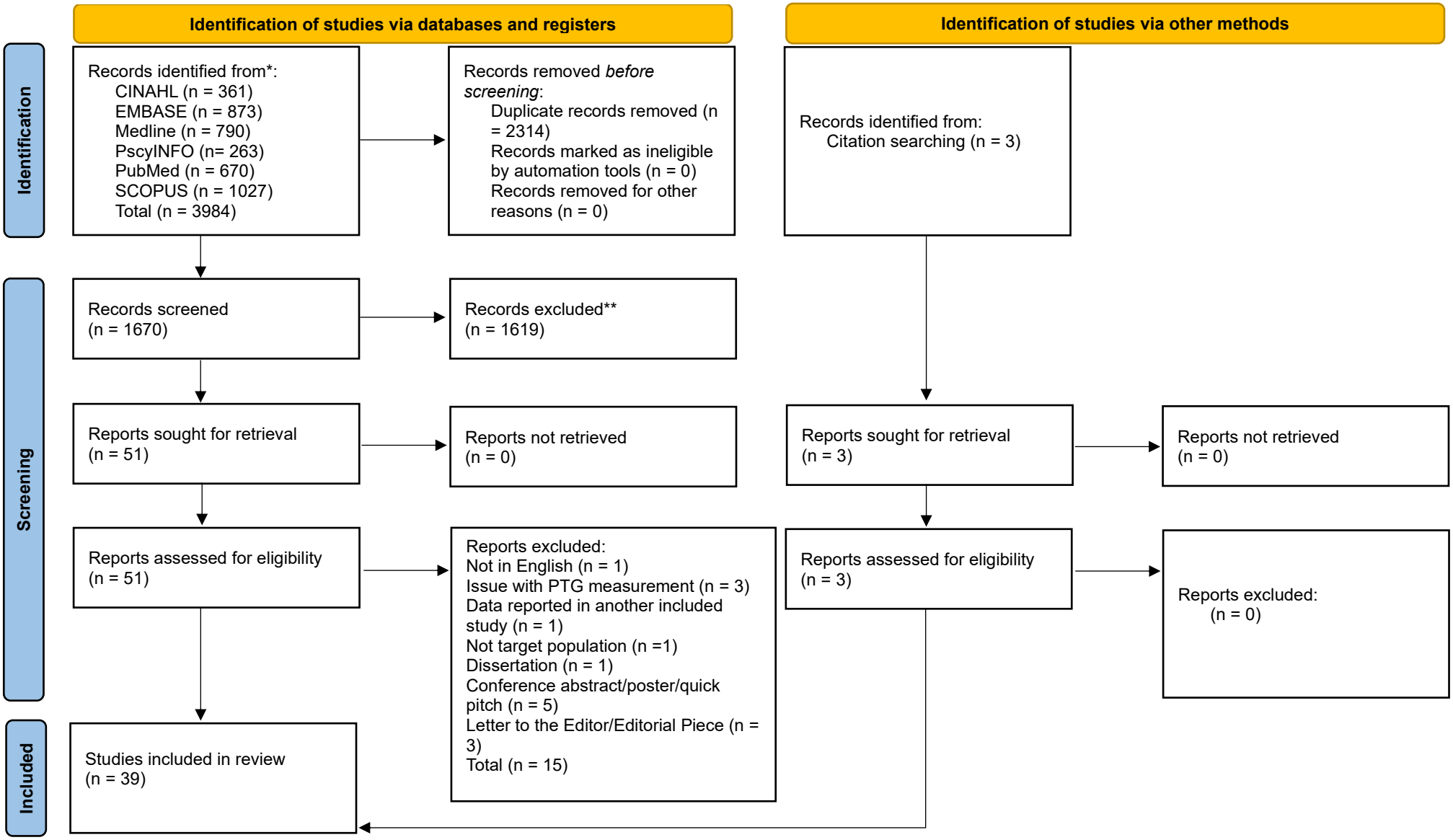

**Table 1.1**

*Characteristics of the studies included in the systematic review.*

| Reference | Location | Study Design | *N* | Population |
|---|---|---|---|---|
| **Aafjes-van Doorn et a. (2022)** | USA | Prospective Cohort | 185 | Therapists |
| **Aggar et al. (2022)** | Australia | Cross Sectional | 767 | Acute Care Nurses |
| **Andreassi et al. (2021)** | Italy | Mixed Methods | 104 | Healthcare Workers |
| **Atay et al. (2022)** | Turkey | Cross Sectional | 263 | Nurses |
| **Barnicot et al. (2023)** | UK | Cross Sectional | 854 | Community and Mental healthcare staff |
| **Carola et al. (2022)** | Italy | Mixed Methods | 35 | ICU Healthcare Workers |
| **Chen et al. (2021)** | China & Taiwan | Cross Sectional | 12596 | Nurses |
| **Cui et al. (2021)** | China | Cross Sectional | 167 | Nurses |
| **Dahan et al. (2022)** | Israel | Cross Sectional | 183 | Mental Health Nurses |
| **Feingold et al. (2022)** | USA | Prospective Cohort | 787 | Frontline Healthcare Workers |
| **Fernández-ávalos et al. (2022)** | Spain | Quasi-experimental | 32 | Intellectual Disability Workers |
| **Fonseca et al. (2022)** | Portugal | Cross Sectional | 111 | Medical Rescuers |
| **Han et al. (2022)** | Korea | Cross Sectional | 233 | Nurses |
| **Jiang et al. (2022)** | China | Cross Sectional | 3149 | Nurses |
| **Kalaitzaki and Rovithis (2021)** | Greece | Cross Sectional | 673 | Healthcare Workers |
| **Kalaitzaki et al. (2022)** | Greece | Cross Sectional | 647 | Healthcare Workers |
| **Kapur et al. (2022)** | USA | Prospective Cohort | 120 | Radiation Medicine Staff |
| **Labban et al. (2021)** | Saudi Arabia | Cross Sectional | 202 | Dental Providers |
| **Lai et al. (2021)** | China | Cross Sectional | 776 | Psychological Counsellors |
| **Li et al. (2022)** | China | Cross Sectional | 445 | Nurses |
| **Liu et al. (2021)** | China | Cross Sectional | 200 | Nurses |
| **Lv et al. (2021)** | China | Cross Sectional | 1347 | Medical Workers |
| **Lyu et al. (2021)** | China | Study 1: Prospective Cohort<br>Study 2: Cross Sectional | Study 1: 134<br>Study 2: 401 | Healthcare Workers |
| **Mo et al. (2021)** | China | Cross Sectional | 266 | Nurses |
| **Moreno-Jimenez et al. (2021)** | Spain | Prospective Cohort | 172 | Healthcare Workers |
| **Nie et al. (2021)** | China | Cross Sectional | 760 | Frontline Medical Staff |
| **Peng et al. (2021)** | China | Cross Sectional | 116 | Nurses |
| **Pfeiffer et al. (2023)** | USA | Quasi-experimental non-randomized | 163 | Healthcare Workers |
| **Prekazi et al. (2021)** | Kosovo | Cross Sectional | 691 | Healthcare Workers |
| **Raza and Fatima (2022)** | Pakistan | Cross Sectional | 97 | Healthcare Workers |
| **Sarialioglu et al. (2022)** | Turkey | Cross Sectional | 175 | Nurses |
| **Uziel et al. (2021)** | Israel, Canada & France | Cross Sectional | 537 | Dental Personnel |
| **Veronese et al. (2022)** | Palestine | Cross Sectional | 441 | Healthcare Workers |

| | | | | |
|---|---|---|---|---|
| **Yan et al. (2022)** | China | Prospective Cohort | 565 | Healthcare Workers |
| **Yeung et al. (2022)** | Hong Kong | Cross Sectional | 1510 | Nurses |
| **Yilmaz-Karaman et al. (2022)** | Turkey | Prospective Cohort | 66 | Healthcare Workers |
| **Yim and Kim (2022)** | Korea | Cross Sectional | 229 | Nurses |
| **Zhang et al. (2021)** | China | Cross Sectional | 1790 | Nurses |
| **Zhang et al. (2022)** | China | Cross Sectional | 589 | Healthcare Workers |

**Table 1.2**

*MMAT quality appraisal ratings.*

**MMAT Appraisal of Cross-Sectional Studies**

| Reference | Are there clear research questions? | Do the Collected Data Allow Us to Address the Research Questions? | Is the Sampling Strategy Relevant to Address the Research Question? | Is the Sample Representative of the Target Population? | Are the Measurements Appropriate? | Is the Risk of Nonresponse Bias Low? | Is the Statistical Analysis Appropriate to Answer the Research Question? |
|---|---|---|---|---|---|---|---|
| **Aggar et al. (2022)** | Yes | Yes | Yes | No | Yes | No | Yes |
| **Atay et al. (2022)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Barnicot et al. (2023)** | Yes | Yes | Yes | Yes | Yes | Can't tell | Yes |
| **Chen et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Cui et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Yes | Yes |
| **Dahan et al. (2022)** | Yes | Yes | Yes | Can't tell | Yes | No | Yes |
| **Fonseca et al. (2022)** | Yes | Yes | Yes | No | Yes | No | Yes |
| **Han et al. (2022)** | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Jiang et al. (2022)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Kalaitzaki and Rovithis (2021)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Kalaitzaki et al. (2022)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Labban et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | No | Yes |
| **Lai et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Li et al. (2022)** | Yes | Yes | Can't tell | Can't tell | Yes | Can't tell | Yes |
| **Liu et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Yes | Yes |
| **Lv et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Mo et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Nie et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Yes | Yes |
| **Peng et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Prekazi et al. (2021)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |
| **Raza and Fatima (2022)** | Yes | Yes | Yes | Can't tell | Yes | No | Yes |
| **Sarialioglu et al. (2022)** | Yes | Yes | Yes | Yes | Yes | No | Yes |
| **Uziel et al. (2021)** | Yes | Yes | Yes | Can't tell | Can't tell | Can't tell | Yes |
| **Veronese et al. (2022)** | Yes | Yes | Yes | Can't tell | Yes | Can't tell | Yes |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Yeung et al. (2022)** | Yes | Yes | Yes | Yes | Yes | No | Yes |
| **Yim and Kim (2022)** | Yes | Yes | Yes | Can't tell | Yes | Yes | Yes |
| **Zhang et al. (2021)** | Yes | Yes | Yes | Can't Tell | Yes | Can't tell | Yes |
| **Zhang et al. (2023)** | Yes | Yes | Yes | Can't Tell | Yes | Can't tell | Yes |

**MMAT Appraisal of Prospective Cohort and Experimental Studies**

| Reference | Are there clear research questions? | Do the Collected Data Allow Us to Address the Research Questions? | Are the participants representative of the target population? | Are measurements appropriate regarding both the outcome and intervention (or exposure)? | Are there complete outcome data? | Are the confounders accounted for in the design and analysis? | During the study period, is the intervention administered (or exposure occurred) as intended? |
|---|---|---|---|---|---|---|---|
| **Aafjes-van Doorn et al. (2022)** | Yes | Yes | Can't tell | Yes | Can't tell | Yes | Yes |
| **Feingold et al (2022)** | Yes | Yes | Yes | Yes | No | Yes | Yes |
| **Fernández-ávalos et al. (2022)** | Yes | Yes | No | Yes | Yes | Yes | Yes |
| **Kapur et al. (2022)** | Yes | Yes | Can't tell | Yes | Can't tell | No | Yes |
| **Lyu et al. (2021)** | Yes | Yes | Can't tell | Yes | Can't tell | Yes | Yes |
| **Moreno-Jimenez et al. (2021)** | Yes | Yes | Can't tell | Yes | No | Yes | Yes |
| **Pfeiffer et al. (2023)** | Yes | Yes | Can't tell | Yes | No | Yes | No |
| **Yan et al. (2022)** | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| **Yilmaz-Karaman et al. (2022)** | Yes | Yes | Can't tell | Yes | No | Yes | Yes |

**MMAT Appraisal of Mixed Methods Studies**

| Reference | Are there clear research questions? | Do the Collected Data Allow Us to Address the Research Questions? | Is there an adequate rationale for using a mixed methods design to address the research question? | Are the different components of the study effectively integrated to answer the research question? | Are the outputs of the integration of qualitative and quantitative components adequately interpreted? | Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? | Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? |
|---|---|---|---|---|---|---|---|
| **Andreassi et al. (2021)** | Yes | Yes | Yes | Yes | Yes | Yes | Can't tell |
| **Carola et al. (2022)** | Yes | Yes | Yes | Yes | Yes | Yes | Can't tell |

**Table 1.3**

*PTG information for each included study, with studies grouped by PTG measure.*

| Reference | PTG Measure | Total PTG Score (Time 1 or Baseline) M(SD) | Time 2 PTG M(SD) | Time 3 PTG M(SD) | Time 4 PTG M(SD) | PTG Rating |
|---|---|---|---|---|---|---|
| **Andreassi et al. (2021)** | PTGI[a] | 56.84(20.29) | N/A | N/A | N/A | Fair to Moderate |
| **Atay et al. (2022)** | PTGI[b] | 69.95(15.73) | N/A | N/A | N/A | Moderate to High |
| **Carola et al. (2022)** | PTGI[a] | NR | N/A | N/A | N/A | Fair |
| **Cui et al. (2021)** | PTGI[c] | 70.53(17.26) | N/A | N/A | N/A | High |
| **Dahan et al. (2022)** | PTGI[d] | 3.01(0.81) † | N/A | N/A | N/A | Moderate |
| **Fonseca et al. (2022)** | PTGI[f] | 2.21(1.23) † | N/A | N/A | N/A | Low |
| **Jiang et al. (2022)** | PTGI[h] | 97.09(18.47) | N/A | N/A | N/A | High |
| **Kalaitzaki and Rovithis (2021)** | PTGI | 46.6(24.61) | N/A | N/A | N/A | Low |
| **Kalaitzaki et al. (2022)** | PTGI | 46.6(24.61) | N/A | N/A | N/A | Low |
| **Kapur et al. (2022)** | PTGI | 47.70(28.30) | 46.7(28.20) at 15 months later. | N/A | N/A | Fair |
| **Lai et al. (2021)** | PTGI[c] | 50.49(24.02) | N/A | N/A | N/A | Fair to Moderate |
| **Li et al. (2022)** | PTGI[i] | 63.28(23.41) | N/A | N/A | N/A | Moderate |
| **Liu et al. (2021)** | PTGI[c] | 3.18(1.06) † | N/A | N/A | N/A | Moderate |
| **Lv et al. (2021)** | PTGI | 81.81(19.54) | N/A | N/A | N/A | High |
| **Lyu et al. (2021)** | PTGI[c] | Study 1: 3.43(0.66) † Study 2: 2.94(0.74) † | Study 1: 3.92(0.70) † 1 month later. | Study 1: 2.9(0.64) † 3 months later. | N/A | Moderate to High |
| **Mo et al. (2021)** | PTGI | 96.26(21.57) | N/A | N/A | N/A | High |
| **Nie et al. (2021)** | PTGI | 3.98(.72) † | N/A | N/A | N/A | High |
| **Peng et al. (2021)** | PTGI[c] | 65.65(11.50) | N/A | N/A | N/A | Moderate |
| **Prekazi et al. (2021)** | PTGI | 47.13(NR) | N/A | N/A | N/A | Low |
| **Sarialioglu et al. (2022)** | PTGI[j] | 50.98(25.30) | N/A | N/A | N/A | Fair to Moderate |
| **Yan et al. (2022)** | PTGI[c] | 2.89(1.14) † | 3.04(0.92) † 12 months later. | 3.40(0.80) † 24 months later. | N/A | Moderate to High |
| **Yilmaz-Karaman et al. (2022)** | PTGI[n] | 45.04(26.39) | 37.89(26.28) 6 months later. | N/A | N/A | Low |
| **Yim and Kim (2022)** | PTGI[o] | 43.80 (14.65) | N/A | N/A | N/A | Fair to Moderate |
| **Zhang et al. (2021)** | PTGI | 67.17(14.79) | N/A | N/A | N/A | Moderate |
| **Aafjes-van Doorn et al. (2022)** | PTGI-SF | NR | 1.54(.97) † at 12 weeks | 1.34(.92) † at 18 weeks | 1.24 (.83) † at 24 weeks | Low |
| **Aggar et al. (2022)** | PTGI-SF | 21.60(11.72) | N/A | N/A | N/A | Low |
| **Barnicot et al. (2023)** | PTGI-SF | 20.35 (10.92) | N/A | N/A | N/A | Low |
| **Chen et al. (2021)** | PTGI-SF | 28.00 (11.5) | N/A | N/A | N/A | Moderate |
| **Feingold et al. (2022)** | PTGI-SF | NR | NR | N/A | N/A | Moderate |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Fernández-ávalos et al. (2022)** | PTGI-SF[e] | 20.13(13.37) | 27.20(11.65) at 2 months later. | N/A | N/A | Fair to Moderate |
| **Labban et al. (2021)** | PTGI-SF | 34.17(3.4) | N/A | N/A | N/A | Moderate to High |
| **Moreno-Jimenez et al. (2021)** | PTGI-SF[e] | N/A | 4.11 (0.84) † 7 months later. | N/A | N/A | High |
| **Raza and Fatima (2022)** | PTGI-SF | 3.56(0.83) † | N/A | N/A | N/A | High |
| **Uziel et al. (2021)** | PTGI-SF[kl] | Israel: 17.83(10.30)<br>France: 20.50(11.13)<br>Canada: 21.43(12.17) | N/A | N/A | N/A | Low |
| **Veronese et al. (2022)** | PTGI-SF[m] | 3.62(0.90) † | N/A | N/A | N/A | High |
| **Yeung et al. (2022)** | PTGI-SF | 2.19(0.97) † | N/A | N/A | N/A | Low |
| **Han et al. (2022)** | PTGI-X[g] | 60.15(24.59) | N/A | N/A | N/A | Fair |
| **Pfeiffer et al. (2023)** | PTGI-X | Median= 2.4, Interquartile range (1.2-2.5) † | Median= 2.6, Interquartile range (1.7-3.6) † | N/A | N/A | Fair |
| **Zhang et al. (2022)** | PTGI-X | 76.74(27.13) | N/A | N/A | N/A | Moderate |

Note: † denotes studies whereby PTG appears to have been computed by using mean item scores with a range from 0 -5. NR = not reported. PTG = Posttraumatic growth. M = Mean. SD = Standard Deviation. PTGI-SF = Posttraumatic Growth Inventory – Short Form by Cann et al. (2010). PTGI = Posttraumatic Growth Inventory –by Tedeschi & Calhoun (1996PTGI-X = Posttraumatic Growth Inventory -Expanded by Tedeschi et al. (2017). [a] = Italian version of the PTGI by Prati and Pietrantoni (2014). [b] = Turkish version of the PTGI by Kağan et al. (2012). [c] = Chinese version of the PTGI by Wang et al. (2011). [d] = Hebrew version of the PTGI by Laufer and Solomon (2006). [e] = Spanish version of the PTGI-SF by Castro et al. (2015). [f] = Portuguese version of the PTGI by Da Silva et al. (2009). [g] = Korean version of the PTGI-X by Kim et al. (2020). [h] = Chinese version of the PTGI by Ji et al. (2011). [I] = Chinese version of the PTGI by Dong et al. (2013). [j] = Turkish version of the PTGI by Dürü (2006). [k] = Hebrew version of the PTGI-SF by Leykin et al. (2013). [l] = French version of the PTGI-SF by Cadell et al. (2015). [m] = Arabic version of the PTGI-SF by Veronese and Pepe (2019). [n] = Turkish version of the PTGI by Dirik and Karanci (2008). [o] = Korean version of the PTGI by Song et al. (2009).

**Factors associated with PTG**

Twenty nine studies reported factors associated with PTG. Data which were cross-sectional in nature were used to address this review question, whereas to explore factors which influenced PTG (addressed separately below), only predictors which were measured at a different time to the outcome measure were considered. See table 1.4 for a breakdown of the number of studies which found positive, negative or no association between various factors and PTG. See appendix 1.3 for a more detailed table of these factors, broken down by each study. The factors associated with PTG can be grouped into three overarching categories; namely: Individual Factors, Interpersonal Factors, and Work Related Factors; see Figure 1.2.

***Figure 1.2***

*Categories of Factors Associated with PTG*

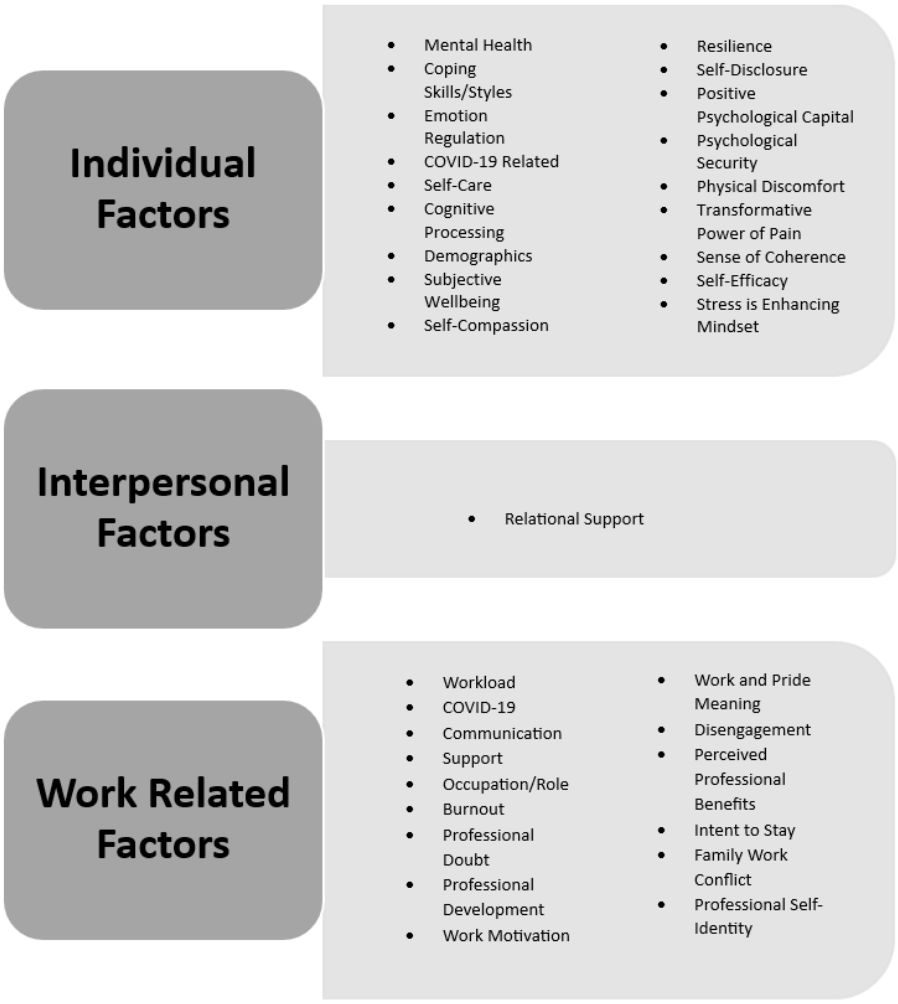

**Table 1.4**

*Factors Associated with PTG.*

| *Factors* | *Significant Positive Association* | *Significant Negative Association* | *No Significant Association* |
|---|---|---|---|
| *Interpersonal Factors* | | | |
| Age | ++++ | - - - - | 00000000 |
| Anxiety | ++ | | 000 |
| Child status | ++++ | | 00000 |
| Coping skills/style/self-care activities | +++++++ | | 0 |
| Covid-19 related stress / anxiety/ fear / worries | ++++++ | - - | |
| Depression | ++ | - | 0 |
| Education level | +++ | - - | 00000 |
| Emotion regulation | ++ | | 0 |
| Gender | +++++ | | 000000000 |
| Marital /cohabitation status | ++++ | | 000000 |
| Non-white ethnicity | ++ | | |
| Physical discomfort | + | | |
| Positive psychological capital | + | | |
| Psychological security | + | | |
| Religiosity | +++ | - | 00 |
| Resilience | ++++++ | | 0 |
| Rumination | +++ | - | |
| Self-compassion | + | | |
| Self-disclosure | + | | 0 |
| Self-efficacy | + | | |
| Sense of coherence | + | | |
| Stress is enhancing mindset | + | | |
| Subjective wellbeing | ++ | | |
| Transformative power of pain | + | | |
| Trauma symptoms | +++ | - - - | 000 |
| *Intrapersonal Factors* | | | |
| Relational Support/Capital | +++++++++ | | 0 |
| *Work Related Factors* | | | |
| Burnout | ++ | - | 0 |
| Caring for Covid-19 patients | ++ | | 000 |
| Communication problems | | - | |
| Disengagement | | - | 0 |
| Intent to stay | + | | |
| Knowledge re Covid-19 | + | | |
| Occupation/Role/ Title | +++++ | - - | 000 |
| Perceived professional benefits | | | |
| Professional development / self-growth | ++ | | |
| Professional doubt | + | | |
| Professional self-identity | ++ | | |
| Support | ++ | | 0 |
| Therapeutic alliance / patient relationship | + | | 0 |
| Training | + | | |
| Workload | +++ | | 00000 |
| Work and pride meaning | + | | |
| Work family conflict | | - | |
| Work motivation | + | | |
| Years of experience | +++ | - | 000000000000 |

*PTG = Posttraumatic Growth. Note that the number of symbols represents the number of studies in which each factor was found to be significantly associated either positively or negatively with PTG or found to have no significant association with PTG.*

***Individual Factors***

***Demographics.*** For age, level of education, gender, marital status, religiosity and child status, the results were inconclusive, with some studies finding these factors positively associated with PTG, some finding negative associations, and a number finding no associations at all between these factors and PTG (see table 1.4). Regarding ethnicity, in the study by Barnicot et al. (2023) higher levels of PTG were found to be associated with Black or Asian ethnicity, with the study by Feingold et al. (2022) also finding higher rates of PTG amongst those with non-white ethnicity.

***Cognitive Processing.*** Rumination is a form of perseverative thinking in which negative or traumatic content is considered and reflected upon (García et al., 2015). It can be deliberate such that one actively chooses to recall and reflect upon the content, or it can be intrusive, such that this content comes to mind without the individual actively choosing to do so. Deliberate rumination was found to be positively associated with PTG in three studies with mixed evidence found for intrusive rumination

***Mental Health.*** For depression, anxiety, trauma symptoms/exposure, and the receipt of or need for psychological/psychiatric intervention, the results were inconclusive, with some studies finding these factors positively associated with PTG, some finding negative associations, and a number finding no associations at all between these factors and PTG (see table 1.4). However, self-disclosure, considered to be the level to which one who has experienced a trauma discusses the event, was found to be positively associated with PTG in the study by Han et al. (2022).

***Resilience.*** Findings on resilience generally indicated a positive association between this factor and PTG (see table 1.4).

***COVID-19 Related.*** Pandemic related stress and fears or worries about contracting COVID-19 were found to be positively associated with PTG in at least one study. The evidence regarding COVID-19 related anxiety, exposure, and contracting COVID-19 was found to be mixed in terms of their association with PTG; see appendix 1.3.

***Emotion Regulation.*** A range of emotion regulation strategies including emotional suppression, venting, and positive reframing, in general, were found to be positively associated with PTG; see appendix 1.3.

***Coping Skills/Styles.*** Generally, support was found for the positive association between a range of coping strategies including, problem or proactive coping strategies, emotion focused coping, and dysfunctional coping strategies, and PTG; see appendix 1.3.

***Self-Care.*** Self-care activities including relaxing, meditation, mindfulness, artistic activities, and exercising were all found to be positively associated with PTG; see appendix 1.3.

***Other.*** Subjective wellbeing, physical discomfort during the pandemic, belief in the transformative power of pain, self-compassion, self-efficacy, the mindset of stress is

enhancing, sense of coherence, positive self-reflection, positive psychological capital, and psychological security were also all found to be positively associated with PTG in at least one study; see table 1.4.

### *Interpersonal Factors*

**Relational Support.** Generally, the presence or perceived presence of social support, utilization of various supports, and more time spent connecting with others, were found to be positively associated with PTG.

### *Work Related Factors*

**Workload.** Atay et al. (2022) found that PTG was positively associated with work hours. Mo et al. (2021) found that mean PTG was highest for those working a mid-number (6-8) of hours per day, whereas Yeung et al. (2022) found that working part-time was negatively associated with PTG. The evidence for providing care to COVID-19 positive patients and duration of care was mixed, with some studies finding positive associations between these and PTG, and some negative; see appendix 1.3.

***Occupation/Job Role.*** The findings regarding job role and job location were inconclusive, with some studies finding those working clinically and in frontline roles to have higher PTG, with others finding the opposite. For years of experience and professional title, the evidence was also mixed, with some studies finding these factors to be positively associated with PTG, some finding negative associations, and some no association at all.

***Burnout.*** For burnout and its three dimensions, the results were inconclusive, with a couple of studies finding these factors positively associated with PTG, one finding negative associations, and one finding no associations at all between these factors and PTG (see table 1.4).

***COVID-19.*** Previous experience in public health emergencies, feeling well prepared for and confident about frontline work, satisfaction with workplace pandemic control measures, fear of treating patients, along with awareness of risks, were all positively associated with PTG; see appendix 1.3.

***Meaning.*** Work pride and meaning was found to be positively associated with PTG in the study be Feingold et al. (2022), meaning in life was found to be positively associated with PTG in the study by Han et al. (2022), and searching for meaning was positively associated with PTG in the study by Lai et al. (2021).

**Communication.** In the study by Atay et al. (2022), they found that participants who had no communication problems at work had higher median PTG levels than those who did.

**Support.** Findings regarding various types of organizational support generally indicated positive associations between these and PTG.

***Other.*** Professional self-doubt, professional self-identity, perceived professional benefits, intent to stay, greater professional development, and work motivation were all

found in at least one study to be positively associated with PTG. Finally, family-work conflict was found to be negatively associated with PTG in the study by Lv et al. (2021).

**Factors which influence PTG**

In order to identify the factors which influenced PTG, in this review we decided that temporal precedence needed to be established. As such, only studies using a prospective cohort or experimental design were considered eligible to address this review question. A total of five studies reported factors found to influence PTG; see table 1.5 for information on these factors.

Aafjes-van Doorn et al. (2022) found that level of PTG remained relatively stable over the duration of their study as the no-change model showed adequate model fit (Chi-square = 12.28 (df = 6), CFI = .94, RMSEA = .08). They also found that baseline scores of acceptance of online therapy and vicarious trauma significantly predicted the intercept of PTG positively (p = .009 and .02, respectively), indicating that greater acceptance of online therapy and more vicarious trauma at baseline both predicted constant, higher level of PTG for 12 to 24 weeks follow-up after the start of the pandemic. Specifically, an increase of 1 unit in the measures of acceptance of online therapy and vicarious trauma, respectively, predicted an increase of .32 and .14 in the stable level of PTG.

Feingold et al. (2022) used a multivariable model to predict PTG. They found that white ethnicity at time 1 of their study significantly predicted lower PTG at time 2 (OR = 0.63, 95% CI = 0.41 – 0.96). They also found that higher scores on measures of positive emotions (i.e., inspiration, OR = 1.24, 95% CI = 1.02 – 1.53), pandemic related PTSD symptoms (i.e., severity of intrusive thoughts, OR = 1.25, 95% CI = 1.02 – 1.53), dispositional gratitude (OR = 1.35, 95% CI = 1.02 – 1.78), and greater feelings of being inspired by role models (OR = 1.74, 95% CI = 1.26 – 2.41) emerged as independent time 1 predictors of time 2 PTG. This combination of variables was found to account for 19% of the variance in time 2 PTG.

In study 1 by Lyu et al. (2021), they noted that participants on average showed an increase in PTG from time 1 to time 2, which was approximately one month later, and a decrease then at time 3, which was approximately 2 months after time 2. They found significant ($p < .05$) differences between PTG at time 1 and time 2, and at time 2 and time 3. Using structural equation modelling they found that there was a significant, positive association between resilience and PTG at time 1 and time 2, but not at time 3. Specifically, resilience at time 1 positively predicted PTG at time 2, which in turn positively predicted resilience at time 3. They postulated that this occurred because COVID-19 was more under control in China at time 3 and therefore individuals were experiencing lower levels of stress. Lyu et al. (2021), therefore, proposed that resilience is particularly crucial to promote PTG during times of high stress.

**Table 1.5**

*Factors found to Influence PTG.*

| Reference | Factors which positively influence PTG | Other factors investigated |
|---|---|---|
| **Aafjes-van Doorn et al. (2022)** | Acceptance of online therapy & vicarious trauma. | Professional doubt, therapeutic alliance & years of experience. |
| **Feingold et al (2022)** | Non-white ethnicity, higher levels of positive emotions, pandemic related PTSD symptoms, dispositional gratitude, and greater feelings of being inspired by role models. | Age, gender, marital status, years of experience, perceived preparedness, pre-pandemic mental disorder, mental health treatment during the pandemic, self-sufficient coping strategies, socially supported coping strategies, avoidant coping strategies, perceived social support, leadership support and value, sleep hours, physical exercise, hobbies/games, media consumption, food and supplies, pre-deployment training, housing and financial support, being a registered nurse, pre-pandemic burnout, COVID-19 associated stressors, negative emotions, depression, generalized anxiety, work and pride meaning, meditation, artistic activities, and stress reduction and support. |
| **Lyu et al. (2021) Study 1** | Resilience | Occupation and education level. |
| **Yan et al. (2022)** | Older age, shorter career duration, higher education, less time on the frontline, and resilience. | Gender, religion, job title, being a manager. |
| **Yilmaz-Karaman et al. (2022)** | Subjective level of knowledge about COVID-19, and subjective evaluation of the relationship with colleagues. | Age, years of experience, gender, frontline status, marital status. |

PTG = Posttraumatic Growth

Yan et al. (2022) examined PTG over 2 years. They identified 4 classes of PTG trajectory. The "Persistent Low" class always reported low average PTG scores and remained stable in this low level. For the "Steady Increase" class, the PTG levels showed a trend of steady rise from the baseline to the last follow up. The "High with Drop" class accounted for the greatest number of their participants. They showed a high level of PTG at baseline (March 2020), with their level of PTG showing a slight downward trend over the next two years, but it still remained at a high level. The final class was the "Fluctuated Rise" class which showed a medium level of PTG at baseline, with a drop at time 2 (March 2021) and a significant rise at time 3 (March 2022). Using the "Persistent Low" class as the reference category, these authors, through multivariable logistic regression, found that those who were of older age, had shorter career durations, had higher education levels, and spent less time on the frontline, had higher levels of PTG. Additionally, those who had higher levels of resilience at baseline were more likely to exhibit higher levels of PTG for these three groups also.

Finally, in the study by Yilmaz- Karaman et al. (2022), PTG was found to be significantly lower six months after initial measurement. They used multivariable regression analysis in order to identify the variables which predicted this decrease in PTG. They found that subjective knowledge about COVID-19 ($t = -2.47$, $p = .016$), and the subjective evaluation of the relationship with colleagues ($t = -2.69$, $p = .009$) were significant predictors. Inversely, it can be inferred that higher levels of knowledge about COVID-19 and higher subjective evaluation of the relationship with colleagues predict an increase in PTG.

## Discussion

This review represents the first attempt to assess the level of PTG amongst HSCWs in the context of COVID-19 and to explore its associated and influencing factors, with the aim of supporting a basis for targeted interventions for HSCWs. The results highlight that the relationship between traumatic events, such as experiencing a global pandemic, and PTG is complex, and not a single linear relationship. PTG has been found to vary over time within this population of HSCWs, with a range of individual, interpersonal, and work related factors found to be both associated with, and to influence PTG. This heterogeneity needs to be considered in order for public health agencies, governments, organizations, and policy makers to create caring climates within workplaces.

Appreciating the complex relationship between PTG and traumatic events is necessary for the development of interventions aimed at increasing organisational PTG and thereby strengthening healthcare organisations and creating more resilient staff teams. Promoting PTG amongst HSCWs seems worthwhile given that it has been found to be related with outcomes associated with staff retention (Brooks et al., 2018; Vough & Caza. 2017), and with increased wellbeing, self-esteem, and life satisfaction (Helgeson et al., 2006). However, given the mixed findings regarding PTG and mental health, it may be necessary to consider interventions aimed at promoting other factors such as resilience or mental toughness to improve the mental health of HSCWs working through difficult circumstances like COVID-19.

The level of PTG was found to vary greatly across the included studies and the use of differing measures of PTG, inconsistent reporting standards, and differing PTG cut off scores

provided challenges in comparing and integrating this data. The highest levels of PTG were reported in studies conducted in China. China was the epicentre of COVID-19. Whilst this result may simply reflect a greater number of studies on this subject being conducted in China compared to other countries, it is also possible that working at the epicentre of the pandemic may have been an exceptionally traumatising event. Additionally, HSCWs in these studies may have also had previous experience in dealing with the severe acute respiratory syndrome (SARS) pandemic and Middle East respiratory syndrome (MERS) pandemic, compared to HSCWs working in countries which were not affected by these, which may have meant that they felt better prepared for and less distressed and overwhelmed by the COVID-19 pandemic. This is in keeping with the work of Shakespeare-Finch and Lurie-Beck (2014) who found that a reasonable amount of distress may trigger PTG, but that at very high levels PTG decreases or may be unable to be attained.

The present findings in terms of associated and influencing factors of PTG largely match previous review evidence amongst military personnel (Mark et al., 2018), HSCWs generally (O'Donovan & Burke, 2022), and the general population (Henson et al., 2021; Wu et al., 2019). Findings regarding demographic factors which may promote or enable PTG have been very mixed; however, being from an ethnic minority is one demographic factor which has been strongly associated with higher PTG in this previous research. In the present review, being from an ethnic minority was found to both positively be associated with and predict PTG. Henson et al. (2021) have suggested that being part of an ethnic minority is associated with increased discrimination and life adversity, which may in turn facilitate benefit finding. Additionally, Barnicot et al. (2023) highlighted that within their study, the Black and ethnic minority staff were exposed to a great deal of evidence within the media that they were at higher risk of serious illness or death from COVID-19, which may in part explain their higher PTG. They also suggested that there is a likelihood of greater religiosity and community identity among these groups, which may also have increased their PTG.

The finding that trauma symptoms positively influenced PTG fits with previous meta-analytical evidence (Shakespeare-Finch & Lurie-Beck, 2014) which reports that a reasonable amount of distress is required to trigger PTG, otherwise there is no need to revise beliefs about the self and the world in order to regain psychological equilibrium. The finding that rumination was positively associated with PTG was unsurprising, as in the original model of PTG by Tedeschi and Calhoun (2004), rumination as a way of revising systems of beliefs is a key element. Similarly, the finding that self-disclosure was positively associated with PTG is in keeping with this, as self-disclosure may have promoted the development of new narratives and perspectives through conversations with others. In the same vein, social support may increase the likelihood of an individual self-disclosing, whereas emotional support may have helped individuals manage their distress surrounding the COVID-19 pandemic. As outlined in the Tedeschi and Calhoun (2004) model, individuals need to manage their distress in response to traumatic events so that they have adequate cognitive resources available to engage in the necessary cognitive processing around the event, and not become overwhelmed by it. Additionally, systemic support, such as work conditions and cultures which bolster trust and psychological safety, and where staff are actively supported post trauma, can help the individual not to become overwhelmed. Again, in line with this

model, the finding that various coping skills were positively associated with PTG makes sense. HSCWs may have used these coping skills to manage their distress surrounding COVID-19. The finding that resilience positively influenced PTG also makes sense. Resilience at times of high stress may help prevent individuals becoming overwhelmed by traumatic events.

**Limitations**

There are some limitations which should be considered when interpreting the current findings. By including only articles published in English with the full text available, studies which were in press may have been omitted along with more recent investigations where the full text was not yet available. It may have been optimal to report the statistical results of the studies investigating the factors associated with PTG, however due to the range of methods used within these studies, it was not feasible to include these details in this part of the synthesis. Additionally, the small number of studies in which temporal precedence was established meant that we had limited ability to elucidate the full range of factors which may influence PTG for this population. Moreover, inconsistencies in reporting standards, and the use of various tools to measure PTG - especially as there does not appear to be standardized definitive classification criteria, with cut off levels varying between studies - meant that it was difficult to compare and integrate the data on PTG. Overall moderate quality ratings of the included studies also impact the degree of certainty we can have about the conclusions drawn. Finally, it may have been beneficial to explore the different domains of PTG within this population, however the volume of included articles, along with the use of differing measures of PTG which conceptualise it to consist of differing numbers of domains, meant that this was unfeasible.

**Implications for Practice**

Based on the present findings, in order to promote the PTG of HSCWs in response to the current and any future pandemics, individual and organizational factors need to be drawn upon. Workplace conditions and cultures should support HSCWs post trauma and foster trust and psychological safety. There should be clear processes through which staff may access professional support, and procedures through which the most up to date knowledge and information can be disseminated amongst workers. Additionally, interventions which may facilitate cognitive processing by creating space for self-disclosure, along with increasing staff resilience, ability to manage distress and positive coping strategies are needed.

**Future Research**

In the first instance, it would be beneficial if future research attempted to establish defined diagnostic criteria and cut offs for PTG. Then, more studies using longitudinal and or experimental designs, which use consistent reporting standards should be conducted with this population in order to fully elucidate the factors which may promote the development of PTG. It may also be of benefit for consideration to be given to the different domains of PTG within these studies.

## Conclusion

This was the first systematic review which aimed to assess the level of PTG amongst HSCWs in the context of COVID-19 and to explore its associated and influencing factors. Although the results of this study need to be interpreted with caution given issues surrounding the measurement of PTG and the quality of studies, they were largely in keeping with previous research in this area, and they highlighted the need for both individual and organizational factors to be drawn upon in order to promote the PTG of HSCWs in response to COVID-19 and any future pandemics. Future research should initially focus on addressing the issues surrounding the measurement of PTG, before then studies in which temporal precedence is established are conducted so as to further elucidate the factors which promote PTG for this population.

## Declaration

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# Chapter Two: Major Research Project

**The Role of Mental Toughness as a Potential Mediator of Change in Anxiety, Depression and Mental Wellbeing in Response to a Digital Psychological Intervention for NHS Staff Working During the COVID-19 Pandemic.**

Chapter word count: 4771 excluding abstract, tables, figures, references, and appendices.

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# Plain Language Summary

**Background:** The COVID-19 pandemic has been associated with increased mental health difficulties amongst health and social care workers (HSCWs). A randomised controlled trial (RCT) was previously conducted to investigate the usefulness of two digital intervention apps (one pre-existing and one new) in supporting the mental health of HSCWs during the pandemic. This RCT found that compared to a waitlist condition, both digital intervention groups showed signs of improvements in mental health outcomes from before to after intervention. Mental toughness (MT), a set of personal traits which influence the way that individuals assess and approach adversity and challenges, has been found to be related to better mental health outcomes. Given that some people who used the apps also showed increases in MT, it is conceivable that the improvements in anxiety, depression and mental wellbeing scores occurred as a result of these changes in MT.

**Aims:** The aim of the present study was to explore how the digital interventions in the above mentioned RCT resulted in improvements in anxiety, depression, and mental wellbeing scores amongst the HSCWs. It sought to answer whether these improvements occurred via changes in MT.

**Methods:** Data from the participants who took part in the RCT were analysed using statistical software. 'Mediation models', which sought to explain the process by which the digital interventions were related to improved anxiety, depression, and mental wellbeing scores, were conducted in order to identify if mental toughness served as a facilitator of change.

**Results:** The results tentatively suggest that MT served as a facilitator of change but that it accounted for a very small proportion of the change within these models. Specifically, in the analyses examining depression and mental wellbeing, the effects via MT were found to be statistically significant.

**Conclusions:** Future studies with larger sample sizes are necessary in order to provide more support for our findings and to further explore what other factors may explain the process through which the digital interventions were related to the improvements in mental health outcomes.

# Abstract

**Objectives:** A pilot randomised controlled trial (RCT) by De Kock et al. (2022) examined the utility of two digital psychological interventions aimed at supporting NHS staff psychological health during the COVID-19 pandemic. The current study aimed to explore how these digital interventions exerted their effects on anxiety, depression, and mental wellbeing, specifically exploring the extent to which mental toughness (MT) mediated these relationships.

**Design:** This study is a secondary data analysis.

**Methods:** Data from the 169 RCT participants were utilized to investigate multi-categorical mediation models of the relationships between the interventions and mental health outcomes, with baseline values of the outcome and MT controlled for, using both complete-case data, and all available data as a sensitivity analysis. The results of interest were the indirect effect sizes (the magnitude of effect that is mediated through MT).

**Results:** Complete-case data analysis suggested the indirect effects accounted for a very small proportion of the effects, with none statistically significant. The sensitivity analysis found that the indirect effect estimates remained similar to those run with complete-case data, but the confidence intervals were narrower, reflecting greater statistical power for these models, with a number of the indirect effects becoming statistically significant for analyses examining depression and mental wellbeing.

**Conclusions:** The results tentatively add to the nascent body of evidence suggesting that MT may play a role in buffering against depression and promote mental health. Larger studies which are sufficiently powered are required to elucidate further the mechanisms through which these interventions exert their effects.

**Words: 250**



**Keywords:** Mental Toughness, Health and Social Care Workers, Digital Psychological Interventions, staff, COVID-19.

# Introduction

The Coronavirus Disease 2019 (COVID-19) pandemic has extensively impacted mental health worldwide. Systematic review evidence indicates that overall levels of anxiety, depression, stress, and post-traumatic stress disorder have increased amongst health and social care workers (HSCWs), patients with pre-existing conditions, and the general public, globally in the context of COVID-19 (Cénat et al., 2021; De Kock et al., 2021; Luo et al., 2020; Pappa et al., 2020; Robinson et al., 2022). Robinson et al. (2022) noted a trend amongst the general population whereby an initial deterioration of mental health coinciding with the commencement of the COVID-19 pandemic, was followed by return to pre-pandemic levels within approximately 6 months. However, the same has not been reported for HSCWs. In a review by De Kock and Latham (2023) it was reported that HSCWs experienced worsening mental health over the course of COVID-19 and in its aftermath. This is particularly worrying as HSCWs played a pivotal role in the response to COVID-19, and staff burnout and poor mental health have been found to negatively affect the quality of patient care (Tawfik et al., 2019). As such, the importance of interventions that support the mental health of HSCWs have been noted (De Kock et al., 2021; Luo et al., 2020).

One such intervention was that of De Kock et al. (2022). They conducted a CONSORT compliant parallel-arm pilot randomised controlled trial (RCT). In this RCT they explored the utility of an existing (My Possible Self [MPS]) and a novel (NHS Highland Wellbeing Project [NHSHWBP]) digital psychological intervention which were aimed at supporting NHS staff psychological health during COVID-19. Participants were randomly assigned to one of the digital interventions or a waitlist condition (WL). The primary psychological outcomes were anxiety, depression, and mental wellbeing. Mental toughness (MT) and gratitude were secondary outcomes. All outcomes were measured at baseline, mid-intervention, and post-intervention (T1, T2 and T3). MPS is a smartphone wellbeing app proven to reduce depression, anxiety, and stress over a short duration (Proudfoot et al., 2013). NHSHWBP is based on MPS, however it is population (NHSH staff) and context (COVID-19) specific. Both apps incorporate cognitive behavioural therapy and positive psychology techniques.

NHSHWBP differed from MPS in three main ways. Firstly, a fictional nurse called Iona, provided a coherent narrative for NHSHWBP. Iona guided participants through the app and its interventions, sending automated text messages to increase participant engagement and motivation. Secondly, NHSHWBP was designed using public and personal feedback on the MPS app e.g., regarding the relevance of modules. Thirdly, links to 24-hour support services were provided by NHSHWBP. The intervention lasted 4 weeks, consisting of 2 parts: part 1 (lasting 2 weeks) which focused on increasing participants' happiness, resilience, and well-being, and part 2 (lasting 2 weeks) which focused on managing low mood and anxiety effectively. Overall, patterns of greater improvement in anxiety, depression and mental wellbeing were found for the digital intervention groups compared to the control condition. The pilot RCT was not powered to reliably estimate efficacy, but these results are suggestive that brief digital psychological interventions may be helpful in improving the wellbeing and mental health of HSCWs; however, the mechanisms through which they may exert their effects remain unclear.

Resilience has been suggested to play a role in protecting the mental health of HSCWs during other infectious disease outbreaks including SARS and MERS (De Brier et al., 2020; Magnavita et al., 2021). Resilience is referred to as "the successful adaptation or absence of pathological outcome … following experience with adverse or stressful circumstances or events" p.1025 (Seery et al., 2010). A conceptual review by Windle (2011) noted that it is personal capacities as well as resources in the individual's social and physical environment that facilitate this "bouncing back" in the face of adversity. MT is a concept closely related to resilience. MT is an umbrella term, encompassing positive psychological resources which are critical to achievement in varied contexts as well as in the mental health domain (Gucciardi et al., 2015; Lin et al., 2017). Gucciardi et al. (2015) have deemed MT as critically important for striving (e.g., working toward individual goals or objectives), surviving (e.g., dealing with adversities, demands and challenges), and thriving (e.g., performance or learning gains, sustaining high levels of performance, and experiencing vitality). They have conceptualised MT to consist of seven core personal resources, namely: generalized self-efficacy, buoyancy, success mindset, optimistic style, context knowledge, emotion regulation and attention regulation. MT is thought to differ from resilience in two main ways (Lin et al., 2017); firstly MT is considered to be a set of traits which influence how an individual assesses and approaches adversity and challenges, contrasting with resilience which places emphasis on the role of resources outside the individual in adaption relationships. Secondly, MT does not presuppose the presence of adversity, stress, or risk in the environment.

MT has been found to negatively correlate with adverse mental health outcomes such as depression, anxiety, stress and insomnia in a range of contexts (Brand et al., 2014; Gerber, Brand, et al., 2013; Gerber, Kalak, et al., 2013; Haghighi & Gerber, 2019; Mojtahedi et al., 2021; Mutz et al., 2017). Theoretically it fits why MT may be negatively related with adverse mental health outcomes such as anxiety and depression. It is thought that the personal characteristics which may allow mentally tough individuals to view challenging situations as less stressful and threatening (such as high self-confidence and perceived control) means that they are less likely to be worried by or fear these situations (Mojtahedi et al., 2021) . Similarly, it is postulated that there is a clear incompatibility between depressive symptomology and MT characteristics (Mojtahedi et al., 2021). MT has also been shown to vary across times and situations (Gucciardi et al., 2015) and it may be modifiable and amenable to improvement via psychological skills training (Burnett et al., 2020; Lin et al., 2017; Mojtahedi et al., 2021). However, a lack of empirical evidence for the importance of interventions aimed at increasing MT has also been noted (Lin et al., 2017).

Whilst the digital interventions in the pilot RCT by De Kock et al. (2022) did not target MT specifically, MT increased from baseline to mid-intervention, and again from mid-intervention to post-intervention amongst the participants in the digital intervention groups. The digital intervention groups focused on increasing participant happiness, resilience, and wellbeing, and effectively managing low mood and anxiety. This may have resulted in increases of some of the core personal resources thought to underly MT e.g., generalized self-efficacy, emotion regulation. It therefore is conceivable that that these digital interventions may have exerted their effects on anxiety, depression, and mental wellbeing via changes in MT. Thus, the current study proposed to investigate if this may be the case,

which would in turn provide a rationale for further larger-scale research to understand this better.

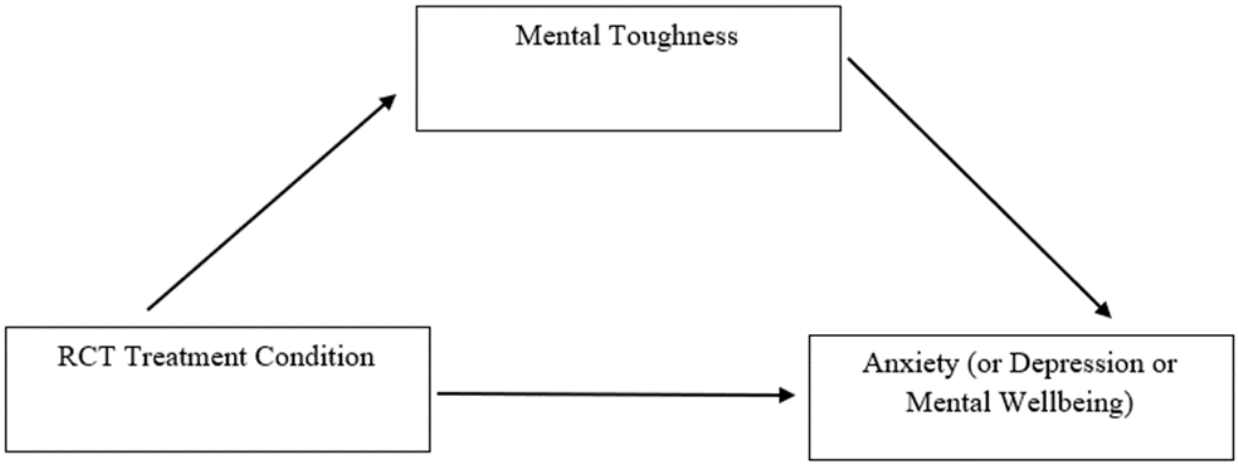
**Aims and Research Questions**

This study aimed to explore the potential mechanisms underlying the suggestive effects that emerged in the RCT by De Kock et al., (2022), specifically, the potential mediatory role of MT in the relationship between the interventions and the mental health outcomes of anxiety, depression, and mental wellbeing. See figure 2.1 for the structure underlying the mediation models explored.

This study aimed to address the following research questions:

1. To what extent does T2 MT mediate the relationship between the NHSHWBP intervention and T3 anxiety?
2. To what extent does T2 MT mediate the relationship between the MPS intervention and T3 anxiety?
3. To what extent does T2 MT mediate the relationship between the NHSHWBP intervention and T3 depression?
4. To what extent does T2 MT mediate the relationship between the MPS intervention and T3 depression?
5. To what extent does T2 MT mediate the relationship between the NHSHWBP intervention and T3 Mental Wellbeing?
6. To what extent does T2 MT mediate the relationship between the MPS intervention and T3 Mental Wellbeing?

***Figure 2.1***
*Model Structure Underlying Planned Mediation Analyses*



# Materials and Methods

## Design

This study was a secondary data analysis using data collected during the RCT by De Kock et al. (2022).

## Ethical Approval

The original RCT gained ethical approval from the Health Research Authority NHS Research Ethics Service (20/SW/0098), management approval from NHS Highland and was registered at ISRCTN18107122. Participants provided their consent for their data to be used in future research. Following discussion about data access permission, this project was sponsored by and received management approval (see appendix 2.1), from NHS Highland Research, Development & Innovation (RD&I) Department.

## Research Procedure

Recruitment for the RCT was conducted both online and locally between July and September 2020, and was supported by NHS Highland Human Resources, GP practice managers, primary and secondary care department heads, along with social media advertisements. Potential participants were directed via weblink to a secure data collection website where they could read the study information sheet and provide informed consent. Eligible participants then completed baseline measures (T1) prior to being randomized to one of the intervention conditions. The intervention coincided with the second wave of COVID-19 in Scotland, from September 7$^{th}$ until October 5$^{th}$, 2020. Participants were asked to complete follow-up measures mid-way through the intervention (two-weeks after baseline; T2) and upon completion of the intervention (four-weeks after baseline; T3).

## Participants

The RCT sample (*N* =169) included NHS staff who were allocated to the pre-existing digital intervention (MPS; *N* = 51), the new digital intervention (NHSHWBP; *N* = 60) or the waitlist (*N* = 58) condition, and included both clinical (e.g., nurses) and non-clinical staff (e.g., administrators). 39 participants did not complete measures at T2 and a further 23 did not complete measures at T3, leaving complete-case data for 107 participants. Eligibility criteria included: being a UK resident, over the age of 18, owning an internet enabled mobile phone, and being an NHS Highland employee in the areas of health and social care during COVID-19.

## Measures

The participants were asked to provide demographic and work-related information at T1, and to complete psychological measures at T1, T2, and T3.

***Demographic and work-related information*** included items relating to gender, age, education level, job type, years of experience, contact with COVID-19 patients, and previous diagnosis of psychiatric disorder.

***Mental Toughness*** was assessed via the 8-item Mental Toughness Index (MTI) (Gucciardi et al., 2015). Scores range from 8 -56, with higher scores reflecting higher levels of MT. Several studies (Cowden et al., 2020; Gucciardi et al., 2015) have adduced evidence that supports different forms of construct validity (e.g., convergent, criterion) of the MTI. In prior studies, internal consistency reliability estimates for the MTI have been ≥ .87 (Cowden, 2020; Cowden et al., 2020).

***Anxiety*** was assessed via the Generalized Anxiety Disorder (GAD-7) Scale (Spitzer et al., 2006). Scores range from 0 -21, with higher scores reflecting higher levels of anxiety. Psychometric evaluations of the GAD-7 have found that it is a valid and reliable measure of anxiety symptoms in the general public (Löwe et al., 2008) and within psychiatric populations (Rutter & Brown, 2017).

***Depression*** was assessed via the Patient Health Questionnaire (PHQ-9); (Kroenke et al., 2001). Scores range from 0 -27, with higher scores reflecting higher depression levels. It is one of the most popular measures for assessing depression in both psychiatric and general populations (Manea et al., 2012) and has been shown to have good test-retest reliability and internal validity (Kroenke et al., 2001).

***Mental Wellbeing*** was assessed via the Warwick-Edinburgh Mental Well-being Scale (WEMWBS); (Tennant et al., 2007). Scores range between 14 -70, with higher scores reflecting higher levels of mental wellbeing. Tennant et al. (2007) have validated the use of the WEMWBS in the UK, and more specifically it has been used to assess the mental wellbeing of UK health and social care staff working during the COVID-19 pandemic (Greenberg et al., 2021).

**Statistical Analysis**

SPSS 28 Statistics software was used to calculate descriptive statistics for the sample along with correlations among all variables across the three timepoints. Given the categorical nature of the intervention groups, it was then necessary to complete simple dummy coding to run the mediation analyses. The SPSS AMOS 26 package was utilised to complete multi-categorical mediation analyses for the models which used a Bootstrap estimation approach with 2000 samples and provided 95% bias-corrected confidence intervals (CI), (see table 2.1 for list of main analyses completed and appendix 2.2 for list of supplementary analyses completed). These analyses were run with both complete-case data, and then again with all available data (using stochastic imputation for missing values) as a sensitivity analysis. The main analyses controlled for baseline values of the outcome and mediator variables. The model fit for each model was examined using the following goodness-of-fit indices: the Chi-square value (desired p-value >.05, Bagozzi and Yi (1988)), Comparative Fit Index (CFI: desired value > 0.9, Bentler (1990)), Tucker- Lewis Index (TLI: desired value > 0.9, Bentler (1990)), and Root Mean Square Error of Approximation (RMSEA: desired value <.08, Hu and Bentler (1998)). For each model, the key result of interest was the indirect effect size (the magnitude of effect that is mediated through MT). Given the RCT lacked the power to reliably detect efficacy effects of the interventions, all mediation analyses in this study were considered exploratory in nature, with the primary goal of generating hypotheses for future,

large-scale studies. Therefore, the interpretations focused primarily on the effect sizes and their confidence intervals, rather than p values. The effect size coefficients were unstandardised and so can be interpreted directly in terms of the outcome measure scores.

**Table 2.1**

*Main Mediation Analyses Conducted.*

| INDEPENDENT VARIABLE | MEDIATOR | DEPENDENT VARIABLE | VARIABLES CONTROLLED |
|---|---|---|---|
| **1. NHSHWBP VS WL** | T2 Mental Toughness | T3 Depression | T1 MT & Depression |
| **2. MPS VS WL** | T2 Mental Toughness | T3 Depression | T1 MT & Depression |
| **3. NHSHWBP VS WL** | T2 Mental Toughness | T3 Anxiety | T1 MT & Anxiety |
| **4. MPS VS WL** | T2 Mental Toughness | T3 Anxiety | T1 MT & Anxiety |
| **5. NHSHWBP VS WL** | T2 Mental Toughness | T3 Mental Wellbeing | T1 MT & Mental Wellbeing |
| **6. MPS VS WL** | T2 Mental Toughness | T3 Mental Wellbeing | T1 MT & Mental Wellbeing |

*T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist.*

# Results

## Demographics

The majority of participants were female (n=94, 87.9%), aged over 40 years of age (n=83, 77.6%), had over 10 years of experience in their respective job roles (n=76, 71%), had not previously been diagnosed with a psychiatric condition (n=78, 72.9%), and were not directly working with COVID-19 positive cases (n=85, 79.4%). See table 2.2 for complete-case demographic information and appendix 2.3 for the total sample information.

**Table 2.2**

*Distribution of Participant Characteristics at Baseline for Complete Cases.*

| Characteristic | | Baseline (N=107), n (%) | MPS (N=27), n% | NHSHWBP (N= 34), n% | WL (N= 46), n% |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| | Female | 94 (87.9) | 23 (85.2) | 33 (97.1) | 38 (82.6) |
| | Male | 13 (12.1) | 4 (14.8) | 1 (2.9) | 8 (17.4) |
| **Dependent Children** | | | | | |
| | Yes | 32 (29.9) | 7 (25.9) | 10 (29.4) | 15 (32.6) |
| | No | 74 (69.2) | 20 (74.1) | 24 (70.6) | 30 (65.2) |
| | Missing | 1 (0.9) | 0 (0) | 0 (0) | 1 (2.2) |
| **Age Category** | | | | | |
| | 18-25 | 4 (3.7) | 1 (3.7) | 0 (0) | 3 (6.5) |
| | 26-30 | 4 (3.7) | 3 (11.1) | 0 (0) | 1 (2.2) |
| | 31-40 | 16 (15) | 3 (11.1) | 6 (17.6) | 7 (15.2) |
| | >40 | 83 (77.6) | 20 (74.1) | 28 (82.4) | 35 (76.1) |
| **Job Type** | | | | | |
| | Admin | 13 (12.1) | 4 (14.8) | 2 (5.9) | 7 (15.2) |
| | Doctor | 21 (19.6) | 4 (14.8) | 5 (14.7) | 12 (26.1) |
| | Nurse | 30 (28) | 6 (22.2) | 12 (35.3) | 12 (26.1) |
| | Carer | 4 (3.7) | 1 (3.7) | 1 (2.9) | 2 (4.3) |

| | | | | | |
|---|---|---|---|---|---|
| | Healthcare Assistant | 4 (3.7) | 0 (0) | 2 (5.9) | 2 (4.3) |
| | Allied Health Professional | 12 (11.2) | 4 (14.8) | 6 (17.6) | 2 (4.3) |
| | Other | 23 (21.5) | 8 (29.8) | 6 (17.6) | 9 (19.6) |
| **Work Setting** | | | | | |
| | Community | 41 (38.3) | 10 (37) | 17 (50) | 14 (30.4) |
| | Hospital | 51 (47.7) | 14 (51.9) | 12 (35.3) | 25 (54.3) |
| | Other | 14 (13.1) | 2 (7.4) | 5 (14.7) | 7 (15.2) |
| | Missing | 1 (0.9) | 1 (3.7) | 0 (0) | 0 (0) |
| **Working with Covid-19** | | | | | |
| | Yes | 21 (19.6) | 3 (11.1) | 7 (20.6) | 11 (23.9) |
| | No | 85 (79.4) | 24 (88.9) | 26 (76.5) | 35 (76.1) |
| | Missing | 1 (0.9) | 0 (0) | 1 (2.9) | 0 (0) |
| **Work Disruption** | | | | | |
| | No Disruption | 1 (0.9) | 0 (0) | 0 (0) | 1 (2.2) |
| | Minor Disruption | 11 (10.3) | 1 (3.7) | 4 (11.8) | 6 (13) |
| | Moderate Disruption | 41 (38.3) | 10 (37.0) | 15 (44.1) | 16 (34.8) |
| | Major Disruption | 40 (37.4) | 10 (37.0) | 13 (38.2) | 17 (37) |
| | Severe Disruption | 14 (13.1) | 6 (22.2) | 2 (5.9) | 6 (13) |
| **Hours Worked** | | | | | |
| | <20 | 3 (2.8) | 1 (3.7) | 1 (2.9) | 1 (2.2) |
| | 20-30 | 18 (16.8) | 4 (14.8) | 11 (32.4) | 3 (6.5) |
| | 30-40 | 61 (57) | 16 (59.3) | 17 (50) | 28 (60.9) |
| | >40 | 25 (23.4) | 6 (22.2) | 5 (14.7) | 14 (30.4) |
| **Shielding Status** | | | | | |
| | Not Shielding | 93 (86.9) | 25 (92.6) | 33 (97.1) | 35 (76.1) |
| | Personally Shielding | 5 (4.7) | 0 (0) | 0 (0) | 5 (10.9) |
| | Family Member Shielding | 9 (8.4) | 2 (7.4) | 1 (2.9) | 6 (13) |
| **Education Level** | | | | | |
| | ≤ undergraduate | 40 (37.4) | 12 (44.4) | 8 (23.5) | 20 (43.5) |
| | ≥ postgraduate | 67 (62.6) | 15 (55.6) | 26 (76.5) | 26 (56.5) |
| **Years of Experience** | | | | | |
| | >2 | 11 (10.3) | 4 (14.8) | 2 (5.9) | 5 (10.9) |
| | 2-5 | 8 (7.5) | 3 (11.1) | 2 (5.9) | 3 (6.5) |
| | 5-10 | 10 (9.3) | 2 (7.4) | 1 (2.9) | 7 (15.2) |
| | >10 | 76 (71) | 17 (63) | 10 (85.3) | 30 (65.2) |
| | Missing | 2 (1.9) | 1 (3.7) | 0 (0) | 1 (2.2) |
| **Psychiatric Diagnosis** | | | | | |
| | Yes | 29 (27.1) | 6 (22.2) | 5 (14.7) | 18 (39.1) |
| | No | 78 (72.9) | 21 (77.8) | 29 (85.3) | 28 (60.9) |

*NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist.*

The mean and standard deviation of each outcome for the 3 intervention groups and all participants for the complete-cases, are represented in table 2.3. See appendix 2.4 for the descriptive statistics for the whole sample.

**Table 2.3**

*Descriptive Statistics for outcomes at baseline, mid intervention, and post intervention for complete cases.*

| *Outcome* | | *All Participants Mean (SD)* | *MPS Mean (SD)* | *NHSHWBP Mean (SD)* | *W/L Mean (SD)* |
|---|---|---|---|---|---|
| *Anxiety* | | | | | |
| | Baseline | 13.72 (4.94) | 13.52 (5.31) | 14.15 (4.88) | 13.52 (4.87) |
| | Mid Intervention | 13.08 (4.47) | 12.33 (4.13) | 13.06 (4.16) | 13.54 (4.90) |
| | Post Intervention | 12.76 (4.74) | 13.07 (5.22) | 12.12 (3.63) | 13.04 (5.20) |
| *Depression* | | | | | |
| | Baseline | 16.65 (5.12) | 16.19 (5.28) | 16.74 (4.74) | 16.85 (5.38) |
| | Mid Intervention | 16.14 (5.12) | 14.48 (4.20) | 16.41 (5.57) | 16.91 (5.15) |
| | Post Intervention | 15.35 (5.11 | 14.19 (3.27) | 14.68 (4.39) | 16.52 (6.22) |
| *Mental Wellbeing* | | | | | |
| | Baseline | 45.30 (9.76) | 46.67 (10.18) | 45.85 (9.04) | 44.11 (10.10) |
| | Mid Intervention | 46.79 (9.69) | 49.63 (9.51) | 47.74 (8.09) | 44.41 (10.48) |
| | Post Intervention | 47.38 (9.85) | 48.63 (10.28) | 48.15 (7.50) | 46.09 (11.09) |
| *Mental Toughness* | | | | | |
| | Baseline | 38.97 (8.48) | 40.30 (8.03) | 39.21 (7.14) | 38.02 (9.63) |
| | Mid Intervention | 38.78 (9.39) | 40.22 (9.73) | 39.68 (9.51) | 37.26 (9.07) |
| | Post Intervention | 39.89 (9.63) | 39.67 (9.80) | 41.32 (8.33) | 38.96 (10.47) |

## Correlation Analyses

All outcome variables across the 3 timepoints were found to be significantly correlated with each other ($p < .001$). Mental Wellbeing and MT were positively correlated with one another across the timepoints (r ranged from .654 to .836; all $p < .001$), and negatively correlated with anxiety and depression scores (r ranged from -.303 to -.807; all $p < .001$). Anxiety and depression scores were positively correlated with one another (r ranged from .556 to .792; all $p < .001$). See appendices 2.5 and 2.6 for intercorrelations of all outcome variables for the complete case data and total sample.

## Mediation Analyses

### *Complete-Case Data*

Complete-case data was available for 107 participants. The models were found to be a good fit to the data, see appendix 2.7. To estimate the mediating effect of T2 Mental Toughness in the relationship between the interventions and the mental health outcomes, a series of multi-categorical mediation analyses were completed where the WL was the reference group whilst controlling for the baseline value of the outcome and mediator variables, see table 2.4 for main results. Results for the supplementary analyses can be found in appendix 2.8. See figure 2.2 for model structure depicting analyses 1 and 2. If the 95% CI for the indirect effect did not include 0, it meant a significant indirect effect at the level of 0.05.

### Anxiety

The indirect effects were .015 and .011 GAD-7 points for the analyses examining the outcome of anxiety, suggesting that the path via MT only accounted for a very small proportion of these effects within these models. Specifically, in model 3, the total effect of NHSHWBP (vs WL) on T3 anxiety whilst controlling for T1 MT and anxiety was -1.305 (95% CI -2.810 to .371; p = .109); the indirect effect through MT accounted for a small proportion of that effect (.015; 95% CI -.137 to .381), and actually suggested that the indirect effect served to increase T3 anxiety score, however this was not statistically significant (p = .565). In model 4, the total effect of MPS (vs WL) on T3 anxiety whilst controlling for T1 MT and anxiety was .055 (95% CI -1.616 to .1.953; p = .927); the indirect effect through MT accounted for a small proportion of that effect (.01; 95% CI -.111 to .360), and actually suggested that the indirect effect served to increase T3 anxiety score however this was not statistically significant (p = .618).

### Depression

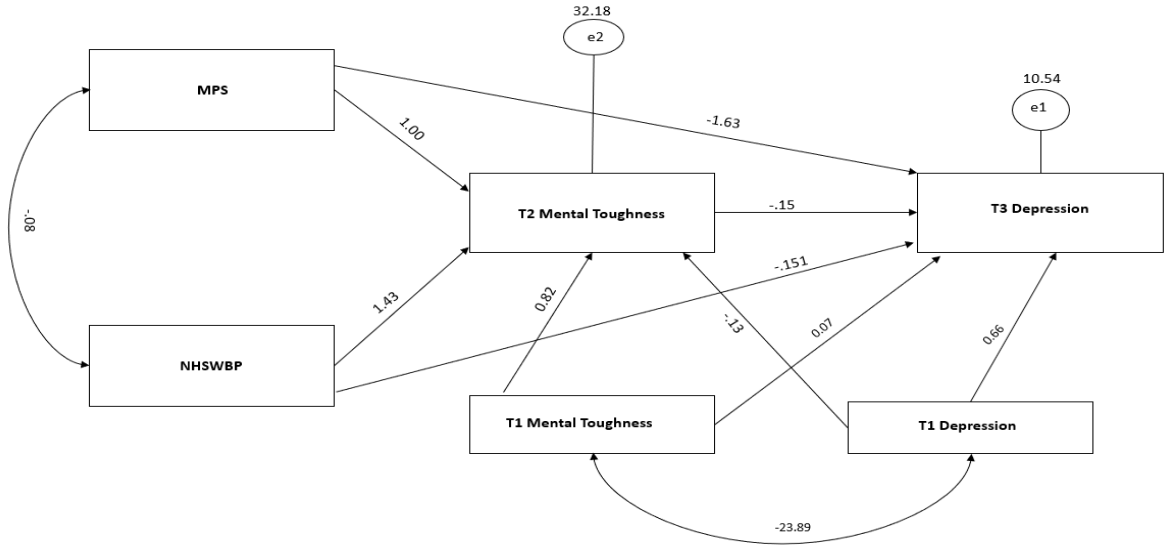
The indirect effects were -.209 and -.147 PHQ-9 points for the two main analyses examining the outcome of depression, suggesting that the path via MT only accounted for a small proportion of the effects within these models. Specifically, in model 1, the total effect of NHSHWBP (vs WL) on T3 depression whilst controlling for T1 MT and depression was -1.714 (95% CI -3.251 to -.163; p = .037); the indirect effect through MT accounted for a small proportion of that effect (-.209; 95% CI -1.005 to .138) but was not statistically significant (p = .244). In model 2, the total effect of MPS (vs WL) on T3 depression whilst controlling for T1 MT and depression was -1.781 (95% CI -3.326 to -.289; p = .025); the indirect effect through MT accounted for a small proportion of that effect (-.147; 95% CI -.818 to .184) but was not statistically significant (p = .343).

### Mental Wellbeing

The indirect effects were .330 and .233 WEMWBS points for the two main analyses examining the outcome of mental wellbeing, suggesting that the path via MT only accounted for a small proportion of the effects within these models. Specifically, in model 5, the total effect of NHSHWBP (vs WL) on T3 mental wellbeing whilst controlling for T1 MT and mental wellbeing was .786 (95% CI -2.065 to 3.543; p = .565); the indirect effect through MT accounted for a small proportion of that effect (.330; 95% CI -.276 to 1.818), however this was not statistically significant (p = .309). In model 6, the total effect of MPS (vs WL) on T3 mental wellbeing whilst controlling for T1 MT and mental wellbeing was .526 (95% CI -2.843 to 4.149; p = .748); the indirect effect through MT accounted for a small proportion of that effect (.233; 95% CI -.37 to 1.417), however this was not statistically significant (p = .389).

***Figure 2.2***

*Model Depicting Analyses 1 & 2*




*Note: Unstandardized coefficients reported, representing the original score units of the questionnaires.*

**Table 2.4**

*Complete-Case Mediation Analyses (n = 107) controlling for baseline values of the outcome and/or mediator variables using a Bootstrap Analysis with 95% Confidence Interval.*

| ***Relationships*** | **Total Effect on DV (95% CI; p)** | **Indirect Effect via MT (95% CI; p)** | **Direct Effect not Via MT (95% CI; p)** |
|---|---|---|---|
| **1. NHSHWBP VS WL**<br>**M = T2 Mental Toughness DV = T3 Depression**<br>**CVs = T1 MT & Depression** | -1.714(-3.251 to -.163; p = .037) | -.209 (-1.005 to .138; p = .244) | -1.506(-3.108 to -.017; p = .048) |
| **2. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | -1.781(-3.326 to -.289; p = .025) | -.147 (-.818 to.184; p = .343) | -1.635(-3.130 to -.169; p = .026) |
| **3. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | -1.305(-2.810 to .371; p = .109) | .015 (-.137 to .381; p = .565) | -1.320(-2.861 to .410; p =.124) |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | .055(-1.616 to 1.953; p = .927) | .011 (-.111 to .360; p = .618) | .045(-1.676 to 2.038; p = .916) |
| **5. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .786(-2.065 to 3.543; p = .565) | .330 (-.276 to 1.818; p = .309) | .456(-2.293 to 3.532; p = .712) |
| **6. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .526(-2.843 to 4.149; p = .748) | .233 (-.37 to 1.417; p = .389) | .296(-3.101 to 3.783; p = .862) |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Unstandardized coefficients reported. Bootstrap sample = 2000 with replacement.*

### *Sensitivity Analyses*

In order to examine the robustness of the primary analyses, all models were run again with all available data using stochastic imputation. The model fit for each model disimproved slightly, see appendix 2.9. It was noted that the indirect effect sizes in this group of analyses remained relatively similar to those in the primary analyses (range: -.196 to .306); however, a general pattern was detected in that the CIs became narrower for each effect within the models, thus indicating that the effects had been estimated more precisely given the larger sample size, see table 2.5 for main results and appendix 2.10 for supplementary results.

#### Anxiety

The indirect effects were -.007 to -.008 GAD-7 points for the two main analyses examining the outcome of anxiety, suggesting that the path via MT only accounted for a very small proportion of the effects within these models. Specifically, in model 3, the total effect of NHSHWBP (vs WL) on T3 anxiety whilst controlling for T1 MT and anxiety was -1.147 (95% CI -1.529 to .703; p = .001); the indirect effect through MT accounted for a small proportion of that effect (-.007; 95% CI -.044 to .016), but this was not statistically significant (p = .443). In model 4, the total effect of MPS (vs WL) on T3 anxiety whilst controlling for T1 MT and anxiety was .234 (95% CI -.190 to .622; p = .280); the indirect effect through MT accounted for a small proportion of that effect (-.008; 95% CI -.044 to .020), but this was not statistically significant (p = .491).

#### Depression

The indirect effects were -.147 and -.196 PHQ-9 points for the two main analyses examining the outcome of depression, suggesting that the path via MT only accounted for a small proportion of the effects within these models. For model 1, the results revealed a significant indirect effect of the impact of NHSHWBP (vs WL) via MT on T3 depression which was negative (b = -.147, 95% CI [-.299 to -.017], p = .025) whilst controlling for T1 mental toughness and depression. Furthermore, the direct effect of NHSWBP on T3 depression in the presence of the mediator was also found to be significant (b = -1.528, 95% CI [-1.912 to -1.113], p = .001). Hence, T2 mental toughness partially mediated the relationship. For model 2, the results showed a significant negative indirect effect of impact of MPS (vs WL) via MT on T3 depression (b = -.196, 95% CI [-.346 to -.073], p = .002) whilst controlling for T1 mental toughness and depression. The direct effect of MPS on T3 depression in the presence of the mediator was also found to be significant (b = -1.735, 95% CI [-2.157 to -1.353], p <.001), suggesting that T2 mental toughness also partially mediated this relationship.

#### Mental Wellbeing

The indirect effects were .306 and .303 WEMWBS points for the two main analyses examining the outcome of mental wellbeing, suggesting that the path via MT only accounted for a small proportion of the effects within these models. For model 5, the results revealed a significant positive indirect effect of the impact of NHSHWBP (vs WL) via MT on T3 mental wellbeing (b = .306, 95% CI [.072 to .582], p = .013) whilst controlling for T1 mental toughness and mental wellbeing. The direct effect of NHSHWBP on T3 mental wellbeing in the presence of the mediator was not found to be significant (b =.179, 95% CI [-.561 to .941]

p = .630), suggesting that T2 mental toughness mediated a large proportion of the relationship. For model 6, the results revealed a significant positive indirect effect of the impact of MPS (vs WL) via MT on T3 mental wellbeing (b =.303, 95% CI [.082 to .565] p = .008) whilst controlling for T1 mental toughness and mental wellbeing. The direct effect of MPS on T3 mental wellbeing in the presence of the mediator was not found to be significant (b = -.024, 95% CI [-.853 to .726] p = .933), suggesting that T2 mental toughness mediated a large proportion of the relationship.

**Table 2.5**

*Mediation Analyses with all available data using stochastic imputation (n = 169*) controlling for baseline values of the outcome and or mediator variables using a Bootstrap Analysis with a 95% Confidence Interval.*

| ***Relationships*** | **Total Effect on DV (95% CI; p)** | **Indirect Effect via MT (95% CI; p)** | **Direct Effect not Via MT (95% CI; p)** |
|---|---|---|---|
| **1. NHSHWBP VS WL**<br>**M = T2 Mental Toughness DV = T3 Depression**<br>**CVs = T1 MT & Depression** | -1.675(-2.091 to -1.276; p = .001) | -.147 (-.299 to -.017; p = .025) | -1.528(-1.912 to -1.113; p = .001) |
| **2. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | -1.931(-2.370 to -1.536; p = .001) | -.196 (-.346 to -.073; p = .002) | -1.735(-2.157 to -1.353; p = .001) |
| **3. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | -1.147(-1.529 to -.703; p = .001) | -.007 (-.044 to .016; p = .443) | -1.140(-1.530 to -.721; p = .001) |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | .234(-.190 to .662; p = .280) | -.008 (-.044 to .020; p = .491) | .241(-.188 to .668; p = .270) |
| **5. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .485(-.231 to 1.282; p = .175) | .306 (.072 to .582; p = .013) | .179(-.561 to .941; p = .630) |
| **6. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .279(-.566 to 1.136; p = .534) | .303 (.082 to .565; p = .008) | -.024(-.853 to .726; p = .933) |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Unstandardized coefficients reported. Bootstrap sample = 2000 with replacement.* *Stochastic imputation makes use of all available data. For these analyses, 10 versions of the dataset were generated, and the results were pooled.

# Discussion

This study aimed to investigate the potential mediatory role of MT in the relationship between the interventions and the mental health outcomes in the RCT by De Kock et al. (2022). Analysis using the complete-case data suggested that the indirect effects via MT only accounted for a very small proportion of the effects, and none of these were significant. Sensitivity analysis using stochastic imputation, found that the indirect effects remained

relatively similar to those run with complete-case data, but a general trend was detected with the CIs becoming narrower for each effect within the models, with a number of the indirect effects via MT becoming statistically significant for the analyses examining depression and mental wellbeing.

This study attempted to address important gaps in the literature noted by Lin et al. (2017) by utilising longitudinal data to explore the directionality of the relationships between MT and other psychological outcomes, and to provide support for interventions that increase MT. As with previous evidence (Lin et al., 2017) our results corroborate the positive relationship between MT and depression.

Overall, the present study tentatively adds to the emerging body of evidence suggesting that MT may play a role in buffering against the negative effects of mental illnesses such as depression and may promote positive mental health outcomes. Whilst the results from the primary analyses suggested that MT did not reliably play a mediatory role in any of these relationships, it must be acknowledged that by only using complete-case data there may have been a further loss of statistical power, in a study not designed to be sufficiently powered to reliably detect efficacy effects of the interventions. In such cases, it is deemed important to conduct a sensitivity analysis (Graham, 2009). Results from our sensitivity analyses suggested that the findings of our primary analyses are not robust, and that there may indeed be a mediatory role of MT in the relationship between the interventions and depression and mental wellbeing in particular. However, we acknowledge that imputation makes assumptions about the patterns of missingness of data, and therefore the results should be interpreted as speculative, limited by small sample size, along with the use of self-report measures.

Future large-scale studies are required to explore the inconsistency between this study's primary and sensitivity analyses. Based on current findings one might expect to see a general pattern whereby the relationships between digital interventions and mental health outcomes may be significantly mediated by MT, but the size of these effects will likely be small, indicating that other factors may be at play. Specifically, the RCT by De Kock et al. (2022) could be repeated with a larger sample size; and be expanded upon by increasing the number of psychological constructs assessed, e.g., resilience, and by running the interventions in a range of health boards, over a longer period of time. This may allow for the interesting finding of the indirect effect via MT serving to increase anxiety in the complete case analyses to be explored further and to attempt to answer the question posed by Lin et al. (2017) about MT simply being a by-product of positive cognitive attributes that are important for optimal performance and keeping mentally well, or whether being mentally tough is necessary for high levels of cognitive and behavioural performance and keeping well.

More detailed path analyses could also be examined in order to elucidate through what other factors these interventions may exert their effects, such as via resilience, given resilience has been found to serve a protective role in HSCW mental health during other infectious disease outbreaks (De Brier et al., 2020; Magnavita et al., 2021). This understanding may then allow these digital interventions to be modified for optimal

outcomes and allow for the rapid and large-scale dissemination of cost-effective psychological support to HSCWs in future public health emergencies and in the aftermath of COVID-19.

## Conclusion

The current study is a step toward understanding how the digital psychological interventions, designed to support NHS staff well-being in COVID-19, in the pilot RCT by De Kock et al. (2022) exerted their effects. Indirect effect sizes via MT generally only accounted for small proportions of the total effects, therefore indicating that other factors may be at play. The results tentatively suggest that MT may play a role in buffering against the negative effects of mental illnesses such as depression and promoting mental wellbeing. Future large-scale studies are required in order the address the inconsistency between the present study's primary and sensitivity analyses, and to elucidate further the mechanisms through which these interventions may have exerted their effects.

## Declaration

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# Appendices

## Appendix 1.1 – Search Strategies

***CINAHL (EBSCOhost)***

| # | Query | Results from 23 Feb 2023 |
|---|---|---|
| 1 | AB PTG OR AB post traumatic growth OR AB vicarious ptg OR AB stress related growth OR AB adversarial growth OR AB positive by-product OR AB positive change OR AB benefit finding OR AB positive growth OR AB perceived benefits OR AB positive life change OR AB perception of benefits | 10,381 |
| 2 | AB SARS-CoV-2 OR AB ( "2019 nCoV" or "2019nCoV" or "corona virus*" or "coronavirus*" or "COVID" or "COVID19" or "nCov 2019" or "SARS-CoV2" or "SARS CoV-2" or "SARSCoV2" or "SARSCoV-2" or "pandemic" or "corona*" or "covid*" or "severe acute respiratory syndrome coronavirus 2" ) | 168,444 |
| 3 | #1 AND #2 | 361 |

***EMBASE (OVID)***

| # | Query | Results from 23 Feb 2023 |
|---|---|---|
| 1 | PTG.mp. | 2,169 |
| 2 | "posttraumatic growth (psychology)"/ or post traumatic growth.mp. | 1,303 |
| 3 | vicarious ptg.mp. | 1 |
| 4 | stress related growth.mp. | 117 |
| 5 | adversarial growth.mp. | 28 |
| 6 | positive by-product.mp. | 5 |
| 7 | positive change.mp. | 4,396 |
| 8 | benefit finding.mp. | 645 |
| 9 | positive growth.mp. | 1,313 |
| 10 | perceived benefits.mp. | 6,793 |
| 11 | positive life change.mp. | 29 |
| 12 | perception of benefits.mp. | 231 |

| | | |
|---|---|---|
| 13 | ("2019 nCoV" or "2019nCoV" or "corona virus*" or "coronavirus*" or "COVID" or "COVID19" or "nCov 2019" or "SARS-CoV2" or "SARS CoV-2" or "SARSCoV2" or "SARSCoV-2" or "pandemic" or "corona*" or "covid*" or "severe acute respiratory syndrome coronavirus 2").mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word] | 1,380,415 |
| 14 | SARS-CoV-2.mp. or Severe acute respiratory syndrome coronavirus 2/ | 170,137 |
| 15 | 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 | 16,194 |
| 16 | 13 or 14 | 1,380,415 |
| 17 | 15 and 16 | 873 |

***Medline (OVID)***

| # | Query | Results from 23 Feb 2023 |
|---|---|---|
| 1 | PTG.mp. or exp Posttraumatic Growth, Psychological/ | 1,988 |
| 2 | post traumatic growth.mp. | 830 |
| 3 | vicarious ptg.mp. | 1 |
| 4 | stress related growth.mp. | 92 |
| 5 | adversarial growth.mp. | 21 |
| 6 | positive by-product.mp. | 2 |
| 7 | positive change.mp. | 3,139 |
| 8 | benefit finding.mp. | 405 |
| 9 | positive growth.mp. | 1,029 |
| 10 | perceived benefits.mp. | 5,385 |
| 11 | positive life change.mp. | 18 |
| 12 | perception of benefits.mp. | 185 |
| 13 | ("2019 nCoV" or "2019nCoV" or "corona virus*" or "coronavirus*" or "COVID" or "COVID19" or "nCov 2019" or | 981,872 |

| | | |
|---|---|---|
| | "SARS-CoV2" or "SARS CoV-2" or "SARSCoV2" or "SARSCoV-2" or "pandemic" or "corona*" or "covid*" or "severe acute respiratory syndrome coronavirus 2").mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms, population supplementary concept word, anatomy supplementary concept word] | |
| 14 | SARS-CoV-2.mp. or exp SARS-CoV-2/ | 193,334 |
| 15 | 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 | 12,441 |
| 16 | 13 or 14 | 981,872 |
| 17 | 15 and 16 | 790 |

***PsycInfo (Ovid)***

| # | Query | Results from 23 Feb 2023 |
|---|---|---|
| 1 | exp Posttraumatic Growth/ or PTG.mp. | 2,571 |
| 2 | exp Posttraumatic Growth/ or post traumatic growth.mp. | 2,722 |
| 3 | exp Posttraumatic Growth/ or vicarious ptg.mp. | 2,210 |
| 4 | stress related growth.mp. | 292 |
| 5 | exp Posttraumatic Growth/ or adversarial growth.mp. | 2,251 |
| 6 | positive by-product.mp. | 8 |
| 7 | positive change.mp. | 3,600 |
| 8 | benefit finding.mp. | 545 |
| 9 | positive growth.mp. | 496 |
| 10 | perceived benefits.mp. | 3,577 |
| 11 | positive life change.mp. | 32 |
| 12 | perception of benefits.mp. | 109 |
| 13 | ("2019 nCoV" or "2019nCoV" or "corona virus*" or "coronavirus*" or "COVID" or "COVID19" or "nCov 2019" or "SARS-CoV2" or "SARS CoV-2" or "SARSCoV2" or "SARSCoV-2" or "pandemic" or "corona*" or "covid*" or "severe acute respiratory syndrome coronavirus 2").mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word] | 46,523 |
| 14 | SARS-CoV-2.mp. or exp COVID-19/ | 18,138 |
| 15 | 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 | 11,176 |
| 16 | 13 or 14 | 46,523 |

| | | |
|---|---|---|
| 17 | 15 and 16 | 263 |

***PubMed (EBSCOhost)***

| # | Query | Results from 23 Feb 2023 |
|---|---|---|
| 1 | "PTG"[Title/Abstract] OR "vicarious ptg"[Title/Abstract] OR "stress related growth"[Title/Abstract] OR "adversarial growth"[Title/Abstract] OR (("positive"[All Fields] OR "positively"[All Fields] OR "positiveness"[All Fields] OR "positives"[All Fields] OR "positivities"[All Fields] OR "positivity"[All Fields]) AND "by-product"[Title/Abstract]) OR "positive change"[Title/Abstract] OR "benefit finding"[Title/Abstract] OR "positive growth"[Title/Abstract] OR "perceived benefits"[Title/Abstract] OR "positive life change"[Title/Abstract] OR (("percept"[All Fields] OR "perceptibility"[All Fields] OR "perceptible"[All Fields] OR "perception"[MeSH Terms] OR "perception"[All Fields] OR "perceptions"[All Fields] OR "perceptional"[All Fields] OR "perceptive"[All Fields] OR "perceptiveness"[All Fields] OR "percepts"[All Fields]) AND "of benefits"[Title/Abstract]) | 12,450 |
| 2 | "sars cov 2"[Title/Abstract] OR "2019 nCoV"[Title/Abstract] OR "2019nCoV"[Title/Abstract] OR "corona virus*"[Title/Abstract] OR "coronavirus*"[Title/Abstract] OR "COVID"[Title/Abstract] OR "COVID19"[Title/Abstract] OR "nCov 2019"[Title/Abstract] OR "SARS-CoV2"[Title/Abstract] OR "sars cov 2"[Title/Abstract] OR "SARSCoV2"[Title/Abstract] OR "SARSCoV-2"[Title/Abstract] OR "pandemic"[Title/Abstract] OR "corona*"[Title/Abstract] OR "covid*"[Title/Abstract] OR "severe acute respiratory syndrome coronavirus 2"[Title/Abstract] | 865,150 |
| 3 | #1 AND #2 | 670 |

***SCOPUS***

| # | Query | Results from 23 Feb 2023 |
|---|---|---|
| 1 | "2019 nCoV" or "2019nCoV" or "corona virus*" or "coronavirus*" or "COVID" or "COVID19" or "nCov 2019" or "SARS-CoV2" or "SARS CoV-2" or "SARSCoV2" or "SARSCoV-2" or "pandemic" or "corona*" or "covid*" or "severe acute respiratory syndrome coronavirus 2" | 1,384,955 |
| 2 | “PTG” or “post traumatic growth” or “vicarious ptg” or “stress related growth” or “adversarial growth” or “positive by-product” or “benefit finding” or “positive growth” or | 40,322 |

| | | |
|---|---|---|
| | “perceived benefits” or “positive life change” or “perception of benefits” | |
| 3 | #1 AND #2 | 1,027 |

## Appendix 1.2 – Posttraumatic Growth Classification System

The included studies were heterogenous in how they classified PTG level. In order to come up with an internally coherent system, the mean PTG score reported in each study was calculated as a percentage of the total possible PTG score dependent on the PTG measure used. Mean PTG scores which were found to be ≥ 70% of the total possible PTG score were classified as “High”. Mean PTG scores found to be between 65% - 69% of the total possible PTG score were classified as “Moderate to High”. Scores between 55% - 64% were classified as “Moderate”, with scores between 50% -54% classified as “Fair to Moderate”. Scores between 45%-49% were classified as “Fair”, with any mean PTG score found to be <45% of the total possible PTG score classified as “Low”.

# Appendix 1.4 Table of Factors Associated with PTG broken down by Study

*Factors Associated with PTG.*

| Reference | Factors positively associated with PTG | Factors negatively associated with PTG | Other factors investigated |
|---|---|---|---|
| **Aafjes-van Doorn et al. (2022)** | Professional doubt. | | Therapeutic alliance and years of experience. |
| **Aggar et al. (2022)** | Subjective wellbeing & self-compassion. | Depression & pandemic related stress. | Anxiety level, years of experience, and caring for COVID-19 positive patients. |
| **Atay et al. (2022)** | Weekly working hours, number of visits to patients in their rooms, psychological resilience, working in hospitals in Istanbul, staying in a hotel, organizational support from management, in-service training for caring for patients with COVID-19. | Communication problems at work, feeling unprotected by PPE. | Duration of caring for COVID-19 positive patients. |
| **Barnicot et al. (2023)** | Black or Asian ethnicity, female gender, working in a non-clinical role and/or in administrative offices and/or in primary care, working for a particular NHS trust, Greater personal/familial exposure to or risk from COVID-19, increased anxiety about COVID-19, more time spent connecting with others, relaxing, exercising, positive self-reflection, greater professional development at work, feeling supported by one's team at work, feeling support from senior management, feeling support from the UK government, feeling support from the people of the UK. | Working in a community setting, working in a clinical role, and working in mental healthcare. | Age, British Citizenship, frequent exposure to COVID 19 cases, time spent not thinking about work, adequate and restful sleep, access to adequate control measures, access to PPE, psychological resilience, general anxiety, and depression. |
| **Chen et al. (2021)** | Working with COVID-19 patients, working in a COVID-19 designated hospital, years of experience, trauma symptoms, emotional exhaustion, depersonalization, and lack of personal accomplishment. | | Working with COVID-19 patients that died, working in a COVID-19 related department, gender, and working in a critical care unit. |
| **Cui et al. (2021)** | Deliberate rumination, age, education, working years, professional title, previous experience in public health emergencies, psychological intervention or training during COVID-19, feeling well prepared for frontline work, confidence about frontline work and awareness of the risk of frontline work. | Intrusive rumination. | Gender, child status, and religious beliefs. |
| **Dahan et al. (2022)** | Personal resilience, national resilience, religiosity, and professional seniority. | | Gender, age, birth country, religion, and administrative role. |
| **Feingold et al (2022)** | Male gender, non-white race/ethnicity, being a registered nurse, pre-pandemic burnout symptoms, COVID-19 associated stressors, positive emotions, negative emotions, COVID-19 associated PTSD symptoms, depression, generalized anxiety, positive psychological | | Age, marital status, years of experience, perceived preparedness, pre-pandemic mental disorder, mental health treatment during the pandemic, self-sufficient coping strategies, socially supported coping strategies, avoidant coping strategies, |

| | | | |
|---|---|---|---|
| | characteristics, work and pride meaning, meditation, artistic activities, stress reduction and support. | | perceived social support, leadership support and value, sleep hours, physical exercise, hobbies/games, media consumption, food and supplies, pre-deployment training, housing and financial support. |
| **Fonseca et al. (2022)** | Problem focused coping, emotion focused coping, and dysfunctional coping. | Disengagement. | Emotion regulation strategies of cognitive reappraisal and expressive suppression, exhaustion as a dimension of burnout, total burnout, total trauma score and the 3 dimensions of trauma - intrusion, avoidance and hyperarousal. |
| **Han et al. (2022)** | Older age, marital status, religiosity, traumatic event experiences, self-disclosure, social support, intrusive rumination, deliberate rumination, meaning in life, and resilience. | | Gender, cohabitation status, education level, years of experience, experience of self-quarantining, PTSD symptoms. |
| **Kalaitzaki and Rovithis (2021)** | Female gender, self-distraction, active coping, denial, use of emotional support, use of instrumental support, venting, positive reframing, problem focused planning, humour, acceptance, religion, resilience, and self-blame. | Older age, higher level of education, substance use | Marital status, and behavioural disengagement. |
| **Lai et al. (2021)** | Empathy and searching for meaning. | Secondary traumatic stress and mindfulness. | Number of cases seen in past week, and number of trauma cases seen in the past week. |
| **Li et al. (2022)** | Being a frontline nurse, male gender, marital status, years of experience, use of psychological counselling phone app. | | Age, years of experience, educational background, child status, and anxiety. |
| **Liu et al. (2021)** | Positive occupational perception, good nurse patient relationship, recognition from family and friends, sense of belonging to a team, self-growth, intent to stay, and resilience. | | None reported. |
| **Lv et al. (2021)** | Positive psychological capital, perceived social support, suppression, | Family work conflict. | None reported. |
| **Lyu et al. (2021) Study 2** | Resilience | Total burnout, and personal accomplishment dimension of burnout. | Emotional exhaustion and depersonalization elements of burnout. |
| **Mo et al. (2021)** | Professional self-identity, social support, higher level of education, being married, not having children, being from Hubei province, working 6-8 hours per day. | | Gender, age, years of experience, staff title, patient disease severity, whether they had volunteered to do the work, support duration, whether they regretted participating in the support work. |
| **Moreno-Jimenez et al. (2021)** | Fear of contagion, harmonious passion, being a nursing home staff, and being a nurse's aide. | | Workload at both timepoints, lack of staff and PPE at both timepoints, and secondary traumatic stress at both timepoints. |

| | | | |
|---|---|---|---|
| **Nie et al. (2021)** | Relational capital and psychological security. | Age, education, tenure. | Gender |
| **Peng et al. (2021)** | Having a child/children, experiencing physical discomfort during the pandemic, and receipt of social support from friends and family. | | Gender, age, marital status, education level, professional title,<br>years of experience and living with parents before the pandemic. |
| **Prekazi et al. (2021)** | Coping skills, time spent attending to COVID-19 patients. | Being infected with COVID-19. | Symptom severity of own covid 19 infection, gender, direct contact with patients, years of experience, mental health as measured by the GHQ. |
| **Raza and Fatima (2022)** | Religious beliefs, self-regulatory work motivation, and non-self-regulatory work motivation. | | Perception of risk, gender, age, monthly income, years of experience. |
| **Sarialioglu et al. (2022)** | Female gender, transformative power of pain, the need for psychiatric/psychological help during the pandemic. | Older age. | Education level, marital status number of children, income status, years of experience, work department, ways of working, Covid-19 infected friends or family, caring for COVID 19 patients. |
| **Uziel et al. (2021)** | Physical health worries, mental health worries, worries about relationships with family, worries about relationships with friends, concerns about finance, anxiety, depression, age, fear of treating patients, having children under 12. | | None reported |
| **Veronese et al. (2022)** | Subjective wellbeing and sense of coherence. | Burnout, trauma symptoms, COVID-19 anxiety. | None reported. |
| **Yeung et al. (2022)** | Older age, being married, having children, worry about contracting COVID-19, worry about family members contracting COVID-19, psychological distress, satisfaction with workplace pandemic control measures. | Religious affiliation, and not working full time. | Years of experience. |
| **Yim and Kim (2022)** | PTSD symptoms, social support, and deliberate rumination. | | Self-disclosure. |
| **Zhang et al. (2021)** | Higher education level, total coping style, positive coping, negative coping, total social support, objective support, utilization of support, self-efficacy. | More senior professional title and PTSD symptoms. | Age, gender, marital status, work department, child status, and years of experience. |
| **Zhang et al. (2022)** | Stress is enhancing mindset, and engagement in proactive coping strategies. | Older age. | Marital status, child status, educational background, whether close others have been infected or not during COVID-19, whether close others died or not during COVID-19, and years of experience. |

PTG = Posttraumatic Growth

# Appendix 1.4 – PRISMA 2020 Reporting Checklist

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| **TITLE** | | | |
| Title | 1 | Identify the report as a systematic review. | P. 6 |
| **ABSTRACT** | | | |
| Abstract | 2 | See the PRISMA 2020 for Abstracts checklist. | P. 7 |
| **INTRODUCTION** | | | |
| Rationale | 3 | Describe the rationale for the review in the context of existing knowledge. | P. 8 - 9 |
| Objectives | 4 | Provide an explicit statement of the objective(s) or question(s) the review addresses. | P. 10 |
| **METHODS** | | | |
| Eligibility criteria | 5 | Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses. | P. 10 |
| Information sources | 6 | Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted. | P.10 |
| Search strategy | 7 | Present the full search strategies for all databases, registers and websites, including any filters and limits used. | Appendix 1.1 |
| Selection process | 8 | Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process. | P. 10 -11 |
| Data collection process | 9 | Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process. | P. 11 |
| Data items | 10a | List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect. | Tables 1.1, 1.3, 1.4 & 1.5 |
| | 10b | List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information. | P. 11 |
| Study risk of bias assessment | 11 | Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process. | P.11 |
| Effect measures | 12 | Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results. | Table 1.3 |
| Synthesis methods | 13a | Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)). | P. 11 |
| | 13b | Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions. | Appendix 1.2 |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| | 13c | Describe any methods used to tabulate or visually display results of individual studies and syntheses. | Tables 1.1, 1.3, 1.4 & 1.5 |
| | 13d | Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used. | Appendix 1.2 |
| | 13e | Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression). | N/A |
| | 13f | Describe any sensitivity analyses conducted to assess robustness of the synthesized results. | N/A |
| Reporting bias assessment | 14 | Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases). | N/A |
| Certainty assessment | 15 | Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome. | N/A |
| **RESULTS** | | | |
| Study selection | 16a | Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram. | Figure 1.1 |
| | 16b | Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded. | N/A |
| Study characteristics | 17 | Cite each included study and present its characteristics. | Table 1.1 |
| Risk of bias in studies | 18 | Present assessments of risk of bias for each included study. | Table 1.2 |
| Results of individual studies | 19 | For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots. | Table 1.3 |
| Results of syntheses | 20a | For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies. | P. 11 - 27 |
| | 20b | Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect. | P. 11 - 27 |
| | 20c | Present results of all investigations of possible causes of heterogeneity among study results. | N/A |
| | 20d | Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results. | N/A |
| Reporting biases | 21 | Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed. | P. 15 |
| Certainty of evidence | 22 | Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed. | N/A |
| **DISCUSSION** | | | |
| Discussion | 23a | Provide a general interpretation of the results in the context of other evidence. | P. 27 - 29 |

| Section and Topic | Item # | Checklist item | Location where item is reported |
|---|---|---|---|
| | 23b | Discuss any limitations of the evidence included in the review. | P. 29 |
| | 23c | Discuss any limitations of the review processes used. | P. 29 |
| | 23d | Discuss implications of the results for practice, policy, and future research. | P. 29 |
| **OTHER INFORMATION** | | | |
| Registration and protocol | 24a | Provide registration information for the review, including register name and registration number, or state that the review was not registered. | P. 10 |
| | 24b | Indicate where the review protocol can be accessed, or state that a protocol was not prepared. | P. 10 |
| | 24c | Describe and explain any amendments to information provided at registration or in the protocol. | N/A |
| Support | 25 | Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review. | P. 30 |
| Competing interests | 26 | Declare any competing interests of review authors. | P. 30 |
| Availability of data, code and other materials | 27 | Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review. | N/A |

# Appendix 2:1 Management Approval Letter

**Dr Beth Sage**
Research, Development & Innovation Director
NHS Highland RD&I Office
Centre for Health Science
Old Perth Road
Inverness
IV2 3JH

E-mail: beth.sage@nhs.scot

NHS Highland

1 November 2022

NHS Highland RD&I Ref: **HIGHLAND 1838**
NRSPCC Ref: **NA**

Ms Sinead Reilly
Trainee Clinical Psychologist
Department of Psychological Services
Drumossie Unit
New Craigs Hospital, Inverness
Post Code
IV3 8NP
sinead.reilly@nhs.scot

Dear Ms Reilly,

**Management Approval for Non-Commercial Research**

I am pleased to tell you that you now have Management Approval for the research project entitled: **'The Role of Mental Toughness as a Potential Mediator of Change' [Protocol 2_MRP Final Proposal 2614752r_20/04/2022].**

I acknowledge that:

- The project is sponsored by NHS Highland.
- The project has no external funding.
- Ethics approval for the project is not required as this is a NHS staff data collection study.
- The project does not require an Organisational Information Document.

The following conditions apply:

- The responsibility for monitoring and auditing this project lies with the University of Glasgow.
- This study will be subject to ongoing monitoring for Research Governance purposes and may be audited to ensure compliance with the UK Policy Framework for Health

POSITIVE ABOUT DISABLED PEOPLE

and Social Care Research (2018, V3.3 07/11/17, however prior written notice of audit will be given.

- Any researchers coming into NHS Highland for the purposes of carrying out research with patients will require a Letter of Access before starting the study at this site. Please contact a member of the RD&I Governance team at nhsh.nhshighlandresearchpassports@nhs.scot for further assistance, if this is required.
- The paperwork concerning all incidents, adverse events and serious adverse events thought to be attributable to a NHS Highlands participant's involvement in this project should be notified to the NHS Highland RD&I Governance team. Please email documents to nhsh.RandD@nhs.scot.
- You are reminded that all amendments (substantial or non-substantial) to the protocol and associated study documents or to the REC application should be notified to the NHS Highland RD&I Office to obtain amendment approval (nhsh.RandD@nhs.scot). Guidance can be found at https://www.nhsresearchscotland.org.uk/services/permissions-co-ordinating-centre/permissions
- If applicable, monthly recruitment rates should be notified to the NHS Highland RD&I Governance team, detailing date of recruitment and the participant trial ID number (please do not include names or other identifiable information). This should be done by e-mail on the first week of the following month, to Chris Cunningham, RD&I Facilitator at nhsh.RandD@nhs.scot. Please quote your RD&I Highland reference number (Highland 1838).
- Please report any other changes in resources used, or staff involved in the project, to nhsh.RandD@nhs.scot.

*Please quote your RD&I Highland reference number (Highland 1838) on all correspondence.*

Yours sincerely.

Frances Hines
RD&I Manager

cc

| |
|---|
| Jo Fraser, RD&I Administration Assistant, NHS Highland RD&I Division nhsh.RandD@nhs.scot |
| Chris Cunningham, RD&I Facilitator, NHS Highland RD&I Division nhsh.randd@nhs.scot |
| Mhairi Robertson, QA Assistant, NHS Highland RD&I Division , mhairi.robertson@nhs.scot |
| Dr Hannes DeKock, Department of Clinical Psychology, New Craigs Hospital, hannes.de@nhs.scot |
| Dr Breda Cullen, Mental Health and Wellbeing, Academic Centre, Gartnavel Royal Hospital, breda.cullen@glasgow.ac.uk |
| |

# Appendix 2:2 Supplementary Mediation Analyses Conducted

| INDEPENDENT VARIABLE | MEDIATOR | DEPENDENT VARIABLE | VARIABLES CONTROLLED |
|---|---|---|---|
| **1. NHSHWBP VS MPS** | T2 Mental Toughness | T3 Depression | T1 MT & Depression |
| **2. NHSHWBP VS WL** | T2 Mental Toughness | T3 Depression | T1 Depression |
| **3. NHSHWBP VS MPS** | T2 Mental Toughness | T3 Depression | T1 Depression |
| **4. MPS VS WL** | T2 Mental Toughness | T3 Depression | T1 Depression |
| **5. NHSHWBP VS MPS** | T2 Mental Toughness | T3 Anxiety | T1 MT & Anxiety |
| **6. NHSHWBP VS WL** | T2 Mental Toughness | T3 Anxiety | T1 Anxiety |
| **7. NHSHWBP VS MPS** | T2 Mental Toughness | T3 Anxiety | T1 Anxiety |
| **8.MPS VS WL** | T2 Mental Toughness | T3 Anxiety | T1 Anxiety |
| **9. NHSHWBP VS MPS** | T2 Mental Toughness | T3 Mental Wellbeing | T1 MT & Mental Wellbeing |
| **10. NHSWBP VS WL** | T2 Mental Toughness | T3 Mental Wellbeing | T1 Mental Wellbeing |
| **11. NHSHWBP VS MPS** | T2 Mental Toughness | T3 Mental Wellbeing | T1 Mental Wellbeing |
| **12. MPS VS WL** | T2 Mental Toughness | T3 Mental Wellbeing | T1 Mental Wellbeing |

*T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist.*

## Appendix 2:3 Distribution of Participant Characteristics at Baseline for Total Sample.

| *Characteristic* | | *Baseline (N=169), n (%)* | *MPS (N= 51), n (%)* | *NHSHWBP (N= 60), n (%)* | *WL (N= 58), n (%)* |
|---|---|---|---|---|---|
| *Gender* | | | | | |
| | Female | 149 (88.2) | 43 (84.3) | 56 (93.3) | 50 (86.2) |
| | Male | 20 (11.8) | 8 (15.7) | 4 (6.7) | 8 (13.8) |
| *Dependent Children* | | | | | |
| | Yes | 56 (33.1) | 14(27.5) | 19 (31.7) | 23 (39.7) |
| | No | 112 (66.3) | 37 (72.5) | 41 (68.3) | 34 (58.6) |
| | Missing | 1 (0.6) | 0 (0) | 0 (0) | 1 (1.7) |
| *Age Category* | | | | | |
| | 18-25 | 4 (2.4) | 1 (2) | 0 (0) | 3 (5.2) |
| | 26-30 | 10(5.9) | 7 (13.7) | 2 (3.3) | 1 (1.7) |
| | 31-40 | 31 (18.3) | 7 (13.7) | 11 (18.3) | 13 (22.4) |
| | >40 | 124 (73.4) | 36 (70.6) | 47 (78.3) | 41(70.7) |
| *Job Type* | | | | | |
| | Admin | 16 (19.5) | 7 (13.7) | 2 (3.3) | 7 (12.1) |
| | Doctor | 39 (23.1) | 10 (19.6) | 14 (23.3) | 15 (25.9) |
| | Nurse | 48 (28.4) | 13 (25.5) | 19 (31.7) | 16 (27.6) |
| | Carer | 6 (3.6) | 1 (2) | 2 (3.3) | 3(5.2) |
| | Healthcare Assistant | 8 (4.7) | 3 (5.9) | 2 (3.3) | 3 (5.2) |
| | Allied Health Professional | 21 (12.4) | 6 (11.8) | 12 (20.0) | 3 (5.2) |
| | Other | 31 (18.3) | 11 (21.6) | 9 (15.0) | 11 (19.0) |
| *Work Setting* | | | | | |
| | Community | 73 (43.2) | 22 (43.1) | 31 (51.7) | 20 (34.5) |
| | Hospital | 74 (43.8) | 23 (45.1) | 21 (35.0) | 30 (51.7) |
| | Other | 20 (12) | 5 (9.8) | 8 (13.3) | 7 (12.1) |
| | Missing | 2 (1.2) | 1 (2) | 0 (0) | 1 (1.7) |
| *Working with Covid-19* | | | | | |
| | Yes | 38 (22.5) | 8 (15.7) | 13 (21.7) | 17 (29.3) |
| | No | 129 (76.3) | 43 (84.3) | 46 (76.7) | 40 (69.0) |
| | Missing | 2 (1.2) | 0 (0) | 1 (1.7) | 1 (1.7) |
| *Work Disruption* | | | | | |
| | No Disruption | 3 (1.8) | 0 (0) | 1 (1.7) | 2 (3.4) |
| | Minor Disruption | 15 (8.9) | 3 (5.9) | 6 (10.0) | 6 (10.3) |
| | Moderate Disruption | 65 (38.0) | 16 (31.4) | 26 (43.3) | 23 (39.7) |
| | Major Disruption | 66 (39.0) | 24 (47.1) | 22 (36.7) | 20 (34.5) |
| | Severe Disruption | 20 (12) | 8 (15.7) | 5 (8.3) | 7 (12.1) |
| *Hours Worked* | | | | | |
| | <20 | 8 (4.7) | 4 (7.8) | 2 (3.3) | 2 (3.4) |
| | 20-30 | 31 (18.3) | 8 (15.7) | 18 (30.0) | 5 (8.6) |
| | 30-40 | 100 (59.2) | 32 (62.7) | 32 (53.3) | 36 (62.1) |
| | >40 | 30 (17.8) | 7 (13.7) | 8 (13.3) | 15 (25.9) |
| *Shielding Status* | | | | | |
| | Not Shielding | 145 (85.8) | 47 (92.2) | 53 (88.3) | 45 (77.6) |

| | | | | | |
|---|---|---|---|---|---|
| | Personally Shielding | 7 (4.1) | 1 (2.0) | 0 (0) | 6 (10.3) |
| | Family Member Shielding | 17 (10.1) | 3 (5.9) | 7 (11.7) | 7 (12.1) |
| *Education Level* | | | | | |
| | ≤ undergraduate | 65 (38.5) | 24 (47.1) | 16 (26.7) | 25 (43.1) |
| | ≥ postgraduate | 104 (61.5) | 27 (52.9) | 44 (73.3) | 33 (56.9) |
| *Years of Work Experience* | | | | | |
| | >2 | 14 (8.3) | 4 (7.8) | 2 (3.3) | 8 (13.8) |
| | 2-5 | 13 (7.7) | 4 (7.8) | 4 (6.7) | 5 (8.6) |
| | 5-10 | 21 (12.4) | 8 (15.7) | 5 (8.3) | 8 (13.8) |
| | >10 | 119 (70.4) | 34 (66.7) | 49 (81.7) | 36 (62.1) |
| | Missing | 2 (1.2) | 1 (2.0) | 0 (0) | 1 (1.7) |
| *Psychiatric Diagnosis* | | | | | |
| | Yes | 37 (21.9) | 8 (15.7) | 11 (18.3) | 18 (31.0) |
| | No | 131 (77.5) | 43 (84.3) | 49 (81.7) | 39 (67.2) |
| | Missing | 1 (0.6) | | | 1 (1.7) |

*NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist.*

## Appendix 2.4 Descriptive Statistics for outcomes at baseline, mid intervention, and post intervention.

| *Outcome* | | *All Participants Mean (SD)* | *MPS Mean (SD)* | *NHSHWBP Mean (SD)* | *W/L Mean (SD)* |
|---|---|---|---|---|---|
| *Anxiety* | | | | | |
| | Baseline | 13.70 (4.73) | 13.35 (4.97) | 13.69 (4.40) | 14.04 (4.88) |
| | Mid Intervention | 13.25 (4.66) | 12.92 (4.71) | 13.12 (4.31) | 13.61 (4.98) |
| | Post Intervention | 12.76 (4.74) | 13.07 (5.22) | 12.12 (3.63) | 13.04 (5.20) |
| *Depression* | | | | | |
| | Baseline | 16.39 (4.94) | 15.72 (5.11) | 16.43 (4.26) | 16.93 (5.43) |
| | Mid Intervention | 16.07 (5.06) | 14.74 (4.31) | 16.23 (5.47) | 16.98 (5.11) |
| | Post Intervention | 15.35 (5.11) | 14.19 (3.27) | 14.68 (4.39) | 16.52 (6.22) |
| *Mental Wellbeing* | | | | | |
| | Baseline | 45.52 (9.16) | 47.25 (9.42) | 45.42 (8.11) | 44.10 (9.83) |
| | Mid Intervention | 47.21 (9.84) | 50.24 (9.87) | 46.9 (8.68) | 45.12 (10.41) |
| | Post Intervention | 47.38 (9.85) | 48.63 (10.28) | 48.15 (7.50) | 46.09 (11.09) |
| *Mental Toughness* | | | | | |
| | Baseline | 38.93 (8.72) | 40.42 (7.94) | 39.02 (7.97) | 37.53 (9.95) |
| | Mid Intervention | 38.88 (9.35) | 40.74 (9.10) | 39.30 (9.55) | 37.02 (9.20) |
| | Post Intervention | 39.89 (9.63) | 39.67 (9.80) | 41.32 (8.33) | 38.96 (10.47) |

*NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist.*

## Appendix 2.5 Correlation Matrix of outcome variables at baseline, mid intervention, and post intervention for complete cases.

| *Variables* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1. T1 Mental Wellbeing* | - | | | | | | | | | | | |
| *2. T1 Depression* | -.773** | - | | | | | | | | | | |
| *3. T1 Anxiety* | -.637** | .703** | - | | | | | | | | | |
| *4. T1 Mental Toughness* | .746** | -.555** | -.434** | - | | | | | | | | |
| *5. T2 Mental Wellbeing* | .817** | -.660** | -.542** | .674** | - | | | | | | | |
| *6. T2 Depression* | -.651** | .770** | .592** | -.432** | -.792** | - | | | | | | |
| *7. T2 Anxiety* | -.552** | .630** | .740** | -.341** | -.647** | .792** | - | | | | | |
| *8. T2 Mental Toughness* | .690** | -.486** | -.374** | .790** | .731** | -.471** | -.360** | - | | | | |
| *9. T3 Mental Wellbeing* | .720** | -.633** | -.445** | .642** | .849** | -.696** | -.601** | .653** | - | | | |
| *10. T3 Depression* | -.595** | .729** | .503** | -.471** | -.710** | .804** | .713** | -.514** | -.807** | - | | |
| *11. T3 Anxiety* | -.432** | .556** | .652** | -.303** | -.533** | .604** | .824** | -.259** | -.637** | .711** | - | |
| *12. T3 Mental Toughness* | .654** | -.552** | -.413** | .722** | .734** | -.540** | -.499** | .756** | .836** | -.676** | -.549** | - |

*** Correlation is significant at the p < .001 level (Two-Tailed). T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention*

## Appendix 2.6 Correlation Matrix of outcome variables at baseline, mid intervention, and post intervention for total sample.

| *Variables* | *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1. T1 Mental Wellbeing* | - | | | | | | | | | | | |
| *2. T1 Depression* | -.749** | - | | | | | | | | | | |
| *3. T1 Anxiety* | -.648** | .729** | - | | | | | | | | | |
| *4. T1 Mental Toughness* | .714** | -.537** | -.483** | - | | | | | | | | |
| *5. T2 Mental Wellbeing* | .844** | -.669** | -.596** | .693** | - | | | | | | | |
| *6. T2 Depression* | -.649** | .734** | .581** | -.467** | -.751** | - | | | | | | |
| *7. T2 Anxiety* | -.555** | .583** | .755** | -.382** | -.685** | .756** | - | | | | | |
| *8. T2 Mental Toughness* | .649** | -.452** | -.375** | .733** | .687** | -.481** | -.389** | - | | | | |
| *9. T3 Mental Wellbeing* | .720** | -.634** | -.442** | .640** | .848** | -.701** | -.615** | .654** | - | | | |
| *10. T3 Depression* | -.595** | .729** | .500** | -.465** | -.705** | .818** | .721** | -.506** | -.807** | - | | |
| *11. T3 Anxiety* | -.432** | .556** | .651** | -.302** | -.546** | .605** | .827** | -.261** | -.637** | .711** | - | |
| *12. T3 Mental Toughness* | .654** | -.555** | -.411** | .720 ** | .732** | -.543** | -.508** | .750** | .836** | -.676** | -.549** | - |

*** Correlation is significant at the p < .001 level (Two-Tailed). T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention.*

# Appendix 2.7 Goodness of Fit Statistics for Models ran with complete-case data controlling for baseline values of the outcome and or mediator variables.

| | P Value | CFI | TLI | RMSEA |
|---|---|---|---|---|
| **Recommended Values: Sources:** | Insignificant (Bagozzi & Yi, 1988) | >.90 (Bentler, 1990) | >.90 (Bentler, 1990) | <.08 (Hu & Bentler, 1998) |
| ***Main Complete Case Analyses*** | | | | |
| **1. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | P = .852 | 1.000 | 1.041 | .000 |
| **2. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | P =.852 | 1.000 | 1.041 | .000 |
| **3. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | P = .708 | 1.000 | 1.036 | .000 |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | P = .708 | 1.000 | 1.036 | .000 |
| **5. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | P = .816 | 1.000 | 1.031 | .004 |
| **6. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | P = .816 | 1.000 | 1.031 | .000 |
| ***Supplementary Complete Case Analyses*** | | | | |
| **1. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | P = .852 | 1.000 | 1.036 | .000 |
| **2. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | P = .860 | 1.000 | 1.064 | .000 |
| **3. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | P = .860 | 1.000 | 1.053 | .000 |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | P = .860 | 1.000 | 1.064 | .000 |
| **5. NHSHWBP VS MPS** | P = .708 | 1.000 | 1.031 | .000 |

| | | | | |
|---|---|---|---|---|
| **M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | | | | |
| **6. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | P = .830 | 1.000 | 1.091 | .000 |
| **7. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | P = .830 | 1.000 | 1.069 | .000 |
| **8. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | P = .830 | 1.000 | 1.091 | .000 |
| **9. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | P = .816 | 1.000 | 1.029 | .000 |
| **10. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | P = .514 | 1.000 | 1.020 | .000 |
| **11. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | P = .514 | 1.000 | 1.017 | .000 |
| **12. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | P = .514 | 1.000 | 1.020 | .000 |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Some results are repeated because they come from the same model, e.g., primary analyses 1 and 2 were run as one model with two dummy independent variables.*

## Appendix 2.8 Supplementary Complete-Case Mediation Analyses (n = 107) controlling for baseline values of the outcome and/or mediator variables using a Bootstrap Analysis with 95% Confidence Interval.

| *Relationships* | Total Effect on DV (95% CI; p) | Indirect Effect via MT (95% CI; p) | Direct Effect not Via MT (95% CI; p) |
|---|---|---|---|
| **1. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | .067(-1.271 to 1.378; p = .909) | -.062 (-.766 to;.38 p = .698) | .129(-1.243 to 1.341; p = .891) |
| **2. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | -1.746(-3.323 to -.205; p = .205) | -.233 (-1.022 to .064; p = .139) | -1.531(-3.094 to .015; p = .051) |
| **3. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | .094(-1.175 to 1.428; p = .856) | .006 (-.539 to .488; p =.977) | .088(-1.263 to 1.298; p = .919) |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | -1.858(-3.519 to -.367; p = .022) | .400 (-.429 to 2.073; p =.347) | -1.619( -3.101 to -.258; p = .022) |
| **5. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | -1.360(-3.119 to .348; p = .106) | .004 (-.143 to .279; p = .657) | -1.365(-3.119 to .353; p = .106) |
| **6. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | -1.321(-2.84 to .335; p =.112) | -.006 (-.361 to .257; p = .940) | -1.316(-2.863 to .387; p =.113) |
| **7. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | -1.354(-3.083 to .350; p =.114) | .000 (-.177 to .229; p = .806) | -1.354(-3.114 to .339; p = .108) |
| **8. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | .033(-1.689 to 1.910; p = .958) | -.006 (-.392 to .284; p = .811) | .039(-1.697 to 1.976; p = .944) |
| **9. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .260(-3.342 to 3.744; p = .872) | .100 (-.663 to 1.524; p = .673) | .160(-3.206 to 3.806; p = .880) |
| **10. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | .802(-2.123 to 3.638; p = .605) | .396 (-.492 to 2.309; p = .370) | .405(-2.107 to 3.503; p = .688) |
| **11. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | .105(-3.632 to 3.636; p = .957) | -.004 (-1.165 to 1.454; p = .972) | .108(-3.268 to 3.668; p .899) |
| **12. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | .697(-2.904 to 4.438; p =.709) | .400 (-.429 to 2.073; p =.347) | .297(-3.196 to 3.867; p = .816) |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Unstandardized coefficients reported. Bootstrap sample = 2000 with replacement.*

# Appendix 2.9 Goodness of Fit Statistics for Models ran with all available data controlling for baseline values of the outcome and or mediator variables.

| | P Value | CFI | TLI | RMSEA |
|---|---|---|---|---|
| **Recommended Values: Sources:** | Insignificant (Bagozzi & Yi, 1988) | >.90 (Bentler, 1990) | >.90 (Bentler, 1990) | <.08 (Hu & Bentler, 1998) |
| ***Main Sensitivity Analyses*** | | | | |
| **1. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | P = .000 | .992 | .968 | .069 |
| **2. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | P = .000 | .992 | .968 | .069 |
| **3. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | P = .000 | .991 | .966 | .066 |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | P = .000 | .991 | .966 | .066 |
| **5. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | P = .000 | .992 | .969 | .073 |
| **6. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | P = .000 | .992 | .969 | .073 |
| ***Supplementary Sensitivity Analyses*** | | | | |
| **1. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | P =.000 | .992 | .972 | .067 |
| **2. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | P = .001 | .994 | .972 | .062 |
| **3. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | P = .000 | .994 | .972 | .064 |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | P = .001 | .994 | .972 | .062 |
| **5. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | P = .000 | .991 | .967 | .066 |

| | | | | |
|---|---|---|---|---|
| **6. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | P = .047 | .998 | .988 | .035 |
| **7. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | P = .062 | .998 | .990 | .032 |
| **8. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | P = .047 | .998 | .988 | .035 |
| **9. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | P = .000 | .992 | .970 | .072 |
| **10. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | P = .000 | .989 | .943 | .095 |
| **11. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | P = .000 | .989 | .944 | .095 |
| **12. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | P = .000 | .989 | .943 | .095 |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Some results are repeated because they come from the same model, e.g., primary analyses 1 and 2 were run as one model with two dummy independent variables.*

## Appendix 2.10 Supplementary Mediation Analyses with all available data using stochastic imputation (n = 169*) controlling for baseline values of the outcome and or mediator variables using a Bootstrap Analysis with a 95% Confidence Interval.

| *Relationships* | Total Effect on DV (95% CI; p) | Indirect Effect via MT (95% CI; p) | Direct Effect not Via MT (95% CI; p) |
|---|---|---|---|
| **1. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | .303(-.050 to .660; p = .086) | .051 (-.072 to .169; p = .424) | .252(-.104 to .591; p = .156) |
| **2. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | -1.904(-2.330 to -1.489; p = .001) | -.256 (-.394 to -.138; p = .001) | -1.648(-2.060 to -1.250; p = .001) |
| **3. NHSWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | -.031(-.382 to .318; p = .873) | .049 (-.049 to .148; p = .302) | -.080(-.422 to .265; p = .658) |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | -1.923(-2.325 to -1.506; p = .001) | -.364 (-.501 to -.247; p = .001) | -1.559 (-1.948 to -1.353; p = .001) |
| **5. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | -1.341(-1.719 to -.950; p = .001) | .001 (-.007 to .018; p = .540) | -1.342(-1.727 to -.955; p - .001) |
| **6. NHSWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | -1.439(-1.853 to -1.016; p = .001) | .009 (-.050 to .061; p = .736) | -1.449(-1.847 to -1.023; p = .001) |
| **7. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | -1.213(-1.631 to -.821; p = .001) | .022 (.000 to .060; p = .048) | -1.234(-1.648 to -.844; p = .001) |
| **8. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | -.122(-.568 to .333; p = .588) | .012 (-.058 to .081; p = .738) | -.134(-.528 to .318; p = .538) |
| **9. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | -.142(-.944 to .668; p = .723) | -.022 (-.213 to .194; p = .844) | -.120(-.875 to .686; p = .765) |
| **10. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | 1.357(.619 to 2.104; p = .001) | .626 (.312 to .980; p = .001) | .731(.030 to 1.460; p = .042) |
| **11. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | -.359(-1.142 to .466; p = .407) | -.174 (-.421 to .083; p = .168) | -.185(-.906 to .633; p = .709) |
| **12. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing** | .908(.018 to 1.712; p = .047) | .611 (.335 to .903; p = .001) | .297(-.494 to 1.079; p = .449) |

| | | | |
|---|---|---|---|
| **CVs = T1 Mental Wellbeing** | | | |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Unstandardized coefficients reported. Bootstrap sample = 2000 with replacement.* *Stochastic imputation makes use of all available data. For these analyses, 10 versions of the dataset were generated, and the results were pooled.

# Appendix 2.11 MRP Proposal

The MRP Proposal can be accessed at: https://osf.io/zkph4/files/osfstorage/64a06d9467aff8107aee01d7

# Appendix 2.12 Tables reporting Path A and Path B of Completed Mediation Analyses

*Complete-Case reporting of path A and path B (n = 107) controlling for baseline values of the outcome and/or mediator variables using a Bootstrap Analysis with 95% Confidence Interval*.

| ***Relationships*** | **Effect of Group on Mediator (95% CI; p)** | **Effect of Mediator on Outcome Variable (95% CI; p)** |
|---|---|---|
| ***Main Complete Case Analyses*** | | |
| **1. NHSHWBP VS WL**<br>**M = T2 Mental Toughness DV = T3 Depression**<br>**CVs = T1 MT & Depression** | 1.426(-1.464 to 4.272; p = .309) | -.147 (-.278 to - .014; p = .026) |
| **2. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | 1.002(-1.612 to 3.751; p = .417) | -.147 (-.278 to - .014; p = .026) |
| **3. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | 1.470(-1.455 to 4.275; p = .311) | .010 (-.103 to .128; p = .793) |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | 1.039(-1.605 to 3.785; p = .408) | .010 (-.103 to .128; p = .793) |
| **5. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | 1.232(-1.509 to 3.993; p = .378) | .286 (-.043 to .591; p = .095) |
| **6. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .857(-1.678 to 3.277; p = .540) | .286 (-.043 to .591; p = .095) |
| ***Supplementary Complete Case Analyses*** | | |
| **1. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | .424(-2.805 to 3.500; p = .799) | -.147 (-.294 to -.017; p = .028) |
| | | |
| **2. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | 2.316(-1.595 to 5.920; p = .198) | -.100 (-.196 to -.028; p = .010) |
| **3. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | -.060(-4.319 to 4.365; p = .989) | -.100 (-.198 to -.024; p =.013) |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | 2.376(-1.312 to 6.398; p = .217) | -.100 (-.196 to -.028; p = .010) |
| **5. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness** | .430(-2.796 to 3.494; p = .718) | .010(-.108 to .125; p = .821) |

| | | |
|---|---|---|
| **DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | | |
| **6. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | 2.866(-1.056 to 6.697; p =.123) | -.002 (-.086 to .078; p = .957) |
| **7. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | -.093(-4.489 to 4.670; p =.973) | -.002 (-.088 to .077; p = .943) |
| **8. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | 2.959(-1.260 to 7.371; p = .166) | -.002 (-.086 to .078; p = .957) |
| **9. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .375(-2.773 to 3.429; p = .791) | .268 (-.043 to .591; p = .095) |
| **10. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | 1.271(-2.119 to 4.477; p = .451) | .312 (.091 to .569; p = .006) |
| **11. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | -.012(-3.840 to 3.649; p = .983) | .312 (.065 to .573; p = .011) |
| **12. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | 1.283(-1.580 to 4.451; p =.433) | .312 (.091 to .569; p = .006) |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Unstandardized coefficients reported. Bootstrap sample = 2000 with replacement.*

*Path A and path B reporting with all available data using stochastic imputation (n = 169*) controlling for baseline values of the outcome and or mediator variables using a Bootstrap Analysis with a 95% Confidence Interval*.

| ***Relationships*** | **Effect of Group on Mediator (95% CI; p)** | **Effect of Mediator on Outcome Variable (95% CI; p)** |
|---|---|---|
| ***Main Sensitivity Analyses*** | | |
| **1. NHSHWBP VS WL**<br>**M = T2 Mental Toughness DV = T3 Depression**<br>**CVs = T1 MT & Depression** | .885(.090 to 1.669; p = .027) | -.166 (-.195 to - .138; p = .001) |
| **2. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | 1.178(.426 to 1.984; p = .002) | -.166 (-.195 to - .138; p = .001) |
| **3. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | .939(.114 to 1.737; p = .025) | -.007 (-.033 to .019; p = .597) |

| | | |
|---|---|---|
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | 1.114(.403 to 1.905; p = .001) | -.007 (-.033 to .019; p = .597) |
| **5. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | 1.001(.235 to 1.800; p = .013) | .306 (.244 to .369; p = .001) |
| **6. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | .992(.265 to 1.777; p = .008) | .306 (.244 to .369; p = .001) |
| ***Supplementary Sensitivity Analyses*** | | |
| **1. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 MT & Depression** | -.298(-.991 to .416; p = .431) | -.172 (-.201 to -.143; p = .001) |
| **2. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | 2.429(1.389 to 3.416; p = .001) | -.105 (-.126 to -.086; p = .001) |
| **3. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | -.483(-1.458 to .478; p = .309) | -.102 (-.121 to -.082; p =.002) |
| **4. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Depression**<br>**CVs = T1 Depression** | 3.454(2.573 to 4.452; p = .001) | -.105 (-.126 to -.086; p = .001) |
| **5. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 MT & Anxiety** | -.271(-.969 to .482; p = .473) | -.003(-.029 to .021; p = .805) |
| **6. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | 2.775(1.689 to 3.781; p =.001) | .003 (-.017 to .023; p = .757) |
| **7. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | -1.307(-2.535 to -.360; p =.008) | -.017 (-.037 to .003; p = .086) |
| **8. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Anxiety**<br>**CVs = T1 Anxiety** | 3.444(2.501 to 4.412; p = .001) | .003 (-.017 to .023; p = .757) |
| **9. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 MT & Mental Wellbeing** | -.078(-.764 to .651; p = .842) | .285 (.224 to .343; p = .001) |
| **10. NHSHWBP VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | 1.926(1.025to 2.824; p = .002) | .325 (.267 to .376; p = .002) |
| **11. NHSHWBP VS MPS**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | -.557(-1.372 to .252; p = .171) | .312 (.250 to .363; p = .001) |

| | | |
|---|---|---|
| **12. MPS VS WL**<br>**M = T2 Mental Toughness**<br>**DV = T3 Mental Wellbeing**<br>**CVs = T1 Mental Wellbeing** | 1.880(1.064 to 2.700; p =.002) | .325 (.267 to .376; p = .002) |

*Note: M = Mediator, DV= Dependent Variable, CVs = Control Variables, T1 = Baseline, T2 = Mid Intervention, T3 = Post Intervention, NHSHWBP = NHS Highland Staff Wellbeing Project Digital Intervention, MPS = My Possible Self Digital Intervention, WL = Waitlist. Unstandardized coefficients reported. Bootstrap sample = 2000 with replacement.* *Stochastic imputation makes use of all available data. For these analyses, 10 versions of the dataset were generated, and the results were pooled.

# Appendix 2.13 AGReMA Reporting Checklist

A Guideline for Reporting Mediation Analyses (AGReMA) Long-Form Checklist

| Section and topic | Item No. | Item description | Answer |
|---|---|---|---|
| ***Title and Abstract*** | | | |
| Title | 1. | • Identify that the study uses mediation analyses | P. 40 |
| Abstract | 2. | • Provide a structured summary of the objectives, methods, results, and conclusions specific to mediation analyses | P. 42 |
| Introduction | | | |
| Background and rationale | 3. | • Describe the study background and theoretical rationale for investigating the mechanisms of interest<br>• Include supporting evidence or theoretical rationale for why the intervention or exposure might have a causal relationship with the proposed mediators<br>• Include supporting evidence or theoretical rationale for why the mediators might have a causal relationship with the outcomes | P. 43 -44 |
| Objectives | 4. | • State the objectives of the study specific to the mechanisms of interest<br>• The objectives should specify whether the study aims to test or estimate the mechanistic effects | P. 45 |
| ***Methods*** | | | |
| Study registration | 5. | • If applicable, provide references to any protocols or study registrations specific to mediation analyses and highlight any deviations from the planned protocol | Appendix 2.11 |
| Study design and source of data | 6. | • Specify the design of the original study that was used in mediation analyses and where the details can be accessed, supported by a reference<br>• If applicable, describe study design features that are relevant to mediation analyses | P. 46 |

| | | | |
|---|---|---|---|
| Participants | 7. | • Describe the target population, eligibility criteria specific to mediation analyses, study locations, and study dates (start of participant enrollment and end of follow-up) | P. 46 |
| Sample size | 8. | • State whether a sample size calculation was conducted for mediation analyses<br>• If so, explain how it was calculated | P. 46 |
| Effects of interest | 9. | • Specify the effects of interest | P. 48 |
| Assumed causal model | 10 | • Include a graphic representation of the assumed causal model including the exposure, mediator, outcome, and possible confounders | Table 2.1 |
| Causal assumptions | 11. | • Specify assumptions about the causal model | Figure 2.1 |
| Measurement | 12 | • Clearly describe the interventions or exposures, mediators, outcomes, confounders, and moderators that were used in the analyses<br>• Specify how and when they were measured, the measurement properties, and whether blinded assessment was used | P. 46 - 47 |
| Measurement levels | 13. | • If relevant, describe the levels at which the exposure, mediator, and outcome were measured | P. 46 -47 |
| Statistical methods | 14. | • Describe the statistical methods used to estimate the causal relationships of interest<br>• This description should specify analytic strategies used to reduce confounding, model building procedures, justification for the inclusion or exclusion of possible interaction terms, modelling assumptions, and methods used to handle missing data<br>• Provide a reference to the statistical software and package used | P. 47 - 48 |
| Sensitivity analyses | 15 | • Describe any sensitivity analyses that were used to explore causal or statistical assumptions and the influence of missing data | P. 47 |
| Ethical approval | 16. | • Name the institutional research board or ethics committee that approved the study | P. 46 |

| | | | |
|---|---|---|---|
| | | • Provide a description of participant informed consent or ethics committee waiver of informed consent | |
| ***Results*** | | | |
| Participants | 17. | • Describe baseline characteristics of participants included in mediation analyses<br>• Report the total sample size and number of participants lost during follow-up or with missing data | Tables 2.2, 2.3 & P. 48 |
| Outcomes and estimates | 18. | • Report point estimates and uncertainty estimates for the exposure-mediator and mediator-outcome relationships<br>• If inference concerning the causal relationship of interest is considered feasible given the causal assumptions, report the point estimate and uncertainty estimate | P. 50 – 52 & Table 2.4 |
| Sensitivity parameters | 19. | • Report the results from any sensitivity analyses used to assess robustness of the causal or statistical assumptions and the influence of missing data | P. 53 -54 & Table 2.5 |
| ***Discussion*** | | | |
| Limitations | 20. | • Discuss the limitations of the study including potential sources of bias | P. 55 |
| Interpretation | 21. | • Interpret the estimated effects considering the study's magnitude and uncertainty, plausibility of the causal assumptions, limitations, generalizability of the findings, and results from relevant studies | P. 54-56 |
| Implications | 22. | • Discuss the implications of the overall results for clinical practice, policy, and science | P. 55 |
| ***Other information*** | | | |
| Funding and role of sponsors | 23. | • List all sources of funding or sponsorship for mediation analyses and the role of the funders/sponsors in the conduct of the study, writing of the manuscript, and decision to submit the manuscript for publication | P. 56 |

| | | | |
|---|---|---|---|
| Conflicts of interest and financial disclosures | 24. | • State any conflicts of interest and financial disclosures for all authors | P. 56 |
| Data and code | 25. | • Authors are encouraged to provide a statement for sharing data and code for mediation analyses.<br>The data that support the findings of this study are available from Dr. Johannes H. De Kock upon reasonable request. | |