

# Cross cultural “behavioural diagnosis” examining the uptake of the MIND diet, using the COM-B model to inform an intervention.

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## Research

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## Abstract

**Background:** The aim of this study was to develop a “behavioural diagnosis” of factors influencing the uptake of the MIND diet in 40-55-year olds according to the COM-B model, in order to reduce the risk of cognitive decline in later life. Comparing a Mediterranean (Italy) and non-Mediterranean (Northern Ireland) country to inform an intervention. This study also sought to identify intervention functions and behaviour change techniques (BCTs) that are likely to be effective in changing MIND diet behaviour.

**Methods:** This was a qualitative study that was used to elicit beliefs surrounding Capability, Opportunity, Motivation and Behaviour (COM-B) with adhering to a diet associated with a reduced risk of cognitive decline, the Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND diet). This study further elaborated the COM-B components into the 14 domains of the Theoretical Domains Framework (TDF) to further understand behaviour. Twenty-five Northern Irish (NI) and Italian participants were recruited onto the study, to take part in either a focus group or an interview. Participants were both male and female aged between 40-55 years.

**Results:** Thematic analysis revealed that the main barriers to the uptake of the MIND diet were; time, work environment (opportunity), taste preference and convenience (motivation). Culture (motivation), seasonal foods and lack of family support (opportunity) to be a barrier to the Italian sample only. The main facilitators reported were; improved health, memory, planning and organisation (motivation) and access to good quality food (opportunity). Cooking skills, knowledge (capability) and healthy work lunch (opportunity) being a facilitator to the Italian sample only. Five intervention functions and fifteen BCTs were identified for possible inclusion in intervention development.

**Conclusions:** The “behavioural diagnosis” provides comparisons and valuable insight into the personal, social and environmental factors that participants report as barriers and facilitators to the uptake of the MIND diet in the two samples. More barriers to healthy dietary change were found than facilitators. There is a need for interventions that increase capability, opportunity and motivation to aid behaviour change. The “behavioural diagnosis” from this study will be used to design a behaviour change intervention using the subsequent steps from the Behaviour Change Wheel (BCW).

## Background

The global ageing population is increasing, with approximately 50 million people worldwide currently living with dementia. It is estimated that by 2050, there will be over 2 billion people aged 60 years or over, with 131 million predicted to be affected by dementia, which is now the 7th leading cause of death worldwide and a global health crisis [1]. There is no current cure for dementia and current medications only modestly help with symptoms, without changing the course of the disease [2]. Longevity is increasing worldwide, therefore, there is an urgent need to identify potential modifiable risk factors such as diet to promote brain health from an earlier age.

The latest statistics on prevalence of dementia in Europe have shown that overall, Italy has the highest percentage (2.09%) of people living with dementia, compared to the average percentage of the rest of Europe (1.55%), even though Italy is a Mediterranean country and its traditional Mediterranean Diet has been reported to have a range of health benefits [3,4]. In the UK, approximately 850,000 people are estimated to be living with dementia, which is 1.6% of the population.

Research conducted within Mediterranean populations has found a decrease in adherence to the Mediterranean Diet [5–6], with globalisation deeply influencing people’s lifestyle choices, yielding a shift towards westernised eating habits and way of living. While Mediterranean Diet adherence is decreasing, those in midlife report a higher adherence to the Mediterranean diet than the younger population in Italy [7]. As part of the Italian Dementia Plan [8] the priority of objective 1, is to “promote strategies for the primary and secondary prevention of dementia” [8–9]. The main purpose of this objective is to increase knowledge of the general population, families, carers and health professionals regarding prevention, timely diagnosis and treatment [8].

There have been several prospective and cross-sectional studies that have attempted to gain insight into the relationship between the Mediterranean Diet [10], DASH diet (Dietary Approaches to Stop Hypertension) [11] and cognitive function. Several cross-sectional studies in Italy and NI with older adults, found that close adherence to the Mediterranean Diet was associated with lower cognitive impairment [12,13] and better cognitive function [14]. Furthermore, prospective studies in the USA and Europe with both

the Mediterranean Diet and DASH diet over several years with older adults found an association with less cognitive decline [15,16], specifically, improved episodic, semantic and working memory [17].

Prospective studies conducted in midlife over an extended 16-year period also showed a significant association with decreased risk of cognitive impairment [18] and improved psychomotor speed over a 4-month period in midlife [19]. Research has found that a healthy diet in midlife is positively associated with cognitive function [20,21]. Moreover, research on both the DASH and Mediterranean Diet has shown promising results in the protection against cardio risk factors for dementia [22]. However, their dietary components may not specifically capture the levels and types of foods shown to optimize brain health [23]. Therefore, the MIND diet (Mediterranean-DASH Intervention for Neurodegenerative Delay) [23] which is a hybrid of the Mediterranean Diet [10] and DASH diet, was designed to promote the specific components and servings linked to neuroprotection and dementia prevention [23].

The MIND diet promotes 10 healthy foods (Leafy greens, other veg, nuts, berries, fish, poultry, olive oil, beans, whole grains, red wine) and limits 5 other foods (Red meat, butter, cheese, pastries and sweets, fried foods). The MIND diet specifies the consumption of leafy greens and berries. While previous research shows that higher consumption of vegetables is associated with lower risk of cognitive decline [24,25], the strongest association is observed for higher intake of leafy greens [26,27]. Previous research on cognitive function or dementia do not observe protective effects for overall fruit consumption [24,25]. However, berries were shown to slow cognitive decline, particularly in global cognition and verbal memory in older adults [28].

There has been limited research to date investigating the effectiveness of the MIND diet. Morris et al. [29] originally devised the MIND diet and found that the diet can slow cognitive decline over an average of 4.7 years in adults aged 58–98 years old [29]. Interestingly, recent research found that the MIND diet and not the Mediterranean Diet, protected against 12-year incidence of mild cognitive impairment and dementia in older adults [31]. Also, a large observational study with older adults found that longer adherence to the MIND diet was associated with better verbal memory [32].

While there are several reasons why people move from one dietary pattern to another, it is social and cultural changes that have been shown to have contributed to reversal of dietary habits in Southern European countries, with previous research highlighting socio-economic variables associated with adherence to a Mediterranean Diet [33]. Education and income have been shown to be associated with greater adherence to a Mediterranean style eating pattern [34,35].

As we are looking to promote healthy ageing, we are investigating modifiable risk factors in the prevention of cognitive decline. Research has found that a healthy diet in midlife is positively associated with cognitive function in later years [20,21]. Therefore, this study could add support to the dementia strategy research by exploring modifiable risk factors in the prevention of dementia, which could be applied globally.

To our knowledge, this is the first study investigating adherence to the MIND diet at midlife (40–55 years old) in a Mediterranean and non-Mediterranean country. This study addresses this gap in the literature and highlights the perceived barriers and facilitators to adhering to a diet that may promote brain health at midlife and compares those barriers and facilitators to those living in Northern Ireland. The COM-B model is used to develop a “behavioural diagnosis” of what factors need to change in order to change behaviour.

The aim of the study was to establish and compare components of the COM-B model that influence the uptake of the MIND diet in a 40-55-year old Italian and Northern Ireland (NI) sample, that will inform a dietary behaviour change intervention.

Specific objectives were:

- To determine participants perceived capability to the uptake of the MIND diet in 40-55-year olds in a Mediterranean (Italy) and non-Mediterranean (NI) country
- To determine participants opportunity to the uptake of the MIND diet in 40-55-year olds in a Mediterranean (Italy) and non-Mediterranean (NI) country
- To determine participants motivation to the uptake of the MIND diet in 40-55-year olds in a Mediterranean (Italy) and non-Mediterranean (NI) country
- Compare barriers and facilitators to the MIND diet from a Mediterranean and non-Mediterranean country

- Identify intervention functions and BCTs that are likely to change MIND diet behaviour

## Method

### Participants and study design

Twenty-five participants from NI and Twenty-five participants from Rome, Italy, both men and women aged 40-55 years were recruited onto the study, to take part in either a focus group or an interview. Ethical approval was obtained from a University Ethics Committee, which is in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki). Participants were approached by email, Facebook and advertisement leaflet. The invitation email/Facebook message contained some brief information about the study. Interested participants were asked to contact the researcher by email and sent a participant information sheet (PIS), consent form and information leaflet on the MIND diet. Questions asked to participants were the same for both NI and Italian populations. Before the Italian interviews began, questions were translated from English to Italian by a fluent Italian speaker (BG). Questions were then back translated to English to ensure the interpretation of questions [36]. Most of the interviews were spoken in English and those that weren't were translated during the interviews by one of the Italian researchers (BG), to allow the English-speaking researcher (DT) to analysis data. Interviews were conducted at participants workplace. In accordance with the COM-B framework, collecting information to understand the target behaviour, data should be collected from different sources as the most accurate picture will be informed by multiple perspectives, therefore both focus groups and interviews were conducted [37], using open ended questions and lasting between 30-60 minutes each (see Table 1). . The interview and focus group questions were based on guidance using the COM-B [37] model and TDF [38] (Table 1). The model and framework were used both in developing the interview schedule and informing the content analyses used. All participants were asked to complete a personal information form and consent form before the interview/focus group began. Participants were informed that the study was voluntary and that they could withdraw at any time. They were assured of confidentiality regarding any personal information they supplied to the researcher. According to similar behaviour change theories, the ideal sample size for elicitation studies is 25 [39]. Also, similar to other qualitative studies using the COM-B and TDF [40,41], twenty-five NI and Italian participants were recruited onto the study, to take part in either a focus group or an interview

### Materials and procedure

The interview and focus group questions were based on the COM-B model and TDF suggested by Michie et al. [37] (Table 1). The questions tapped into the components of the COM-B and TDF, that of Capability, Opportunity, Motivation and Behaviour to develop a "behavioural diagnosis" towards consuming a healthy diet. A leaflet containing information on the elements of the MIND diet and a booklet containing further information on the elements of the MIND diet and the origins of the diet were given to participants. Before interview began, there was an in-depth discussion on the MIND diet and its components between participant and researcher to ensure participants understood what the diet entailed. Participants were informed of what foods to eat, how often to eat foods and portion sizes required. There was also discussion on dementia risk factors and prevalence in the UK and Italy. All interviews and focus groups were audio recorded.

### Theoretical Framework

The theoretical framework underpinning this research is the COM-B model [37]. The COM-B model is at the core of the Behaviour Change Wheel (BCW), a framework for designing and evaluating interventions. Changing behaviour involves changing one or more of the components of the COM-B model, which stand for, capability (C), opportunity (O), motivation (M) and behaviour (B) (see Figure 1).

The Theoretical Domains Framework (TDF) can be used to expand the COM-B model. The TDF [38], comprises 14 domains, each of which corresponds to a COM-B component and also representing a range of theory-based barriers and facilitators to behaviour [37]. The COM-B model and TDF have been used by several studies to explore barriers and facilitators to behaviour change in sexual health [42], physical activity in obese pregnant women [43] and reducing sugar [40]

### Data Analyses

The data was transcribed verbatim and analysed using thematic analyses [44]. The two main researchers (DT&BG) have extensive experience and training in thematic/content analysis employed within theory of behaviour change frameworks and to inform intervention design. DT is a trainee Health Psychologist with an array of skills and experience in qualitative research analysis and the use of behaviour change theories. The research team have a range of expertise in psychology and nutrition. Two researchers (DT&BG) independently read through the entire dataset and coded the data from each transcript and assigned initial “code names”. A reflective diary was kept ensuring a clear overview of the material. Each code was noted as either “barrier” or “facilitator”, depending on the context in which the code occurred. Initially, there was a 95% agreement of codes, demonstrating an acceptable level of agreement [45]. Discussion between researchers resolved any differences within the coding process. After agreement on codes had been made, an additional step in analysis was taken by applying summative content analysis [46], which involved two researchers searching the text for occurrences of codes and frequency counts for each identified code was calculated. Using a common approach [47,48], TDF domains were judged based on the frequency count of coding for each TDF domain, which had been aggregated from all the factors and behaviour-specific belief statements within that domain. TDF domains were then rank ordered according to the frequency coding to identify which components and domains of the theoretical models were the main barriers and facilitators to the uptake of the MIND diet.

## Results

Table 2 reports the characteristics of a total sample including 25 Italian and 25 NI participants.

Transcripts provided data from 12 of the 14 domains of the TDF in the Italian sample, all 14 domains of the TDF in the NI sample and all components of the COM-B model for both samples. (see Table 3).

The most commonly reported barriers and facilitators fell into: Environmental Context and Resources, Belief about Capabilities, Belief about Consequences, Social Influences, Skills and Knowledge. None of the data fell into, reinforcement and goals, which were the least reported domains in the NI study. (See Tables 4 and 5 for quotes).

### Capability

According to the COM-B model, in order for behaviour to occur, there must be the capability to do it. Capability can be either psychological (knowledge, psychological skills or stamina) to perform the behaviour, or “physical” (having the physical skills, strength or stamina) to perform the behaviour.

#### *Psychological capability*

Psychological Capability was a COM-B component identified as a barrier to adherence to the MIND diet.

**Similarities:** Twenty two percent of the barriers in the Italian sample fell into the psychological component of the COM-B model compared to 29% in the NI study. These barriers fell into 2 of the TDF domains, behaviour regulation and knowledge.

**Differences:** No Italian barriers fell into attention and decision process, unlike the NI study where 10% of barriers fell into this domain.

#### *Knowledge*

**Similarities:** Similar to the NI study, all Italian participants reported having never previously heard of the MIND diet.

**Differences:** Italian participants reported that they recognised that the MIND diet was similar to the MIND diet and to their own diet.

#### *Behaviour regulation*

In terms of dietary patterns, behaviour regulations are the steps taken to ensure that food intake is remembered and conducted, and steps taken to break unhealthy habits.

**Similarities:** In both samples, most of the participants did not monitor their food intake. However, some participants reported that they used to record their food intake to monitor what and how much they ate but are now able to control their diet from memory.

### ***Physical Capability: Skills***

Physical skills are defined as the level of self-efficacy in cooking/eating with MIND diet foods.

***Similarities:*** Skills were reported as a facilitator in both the NI (12%) and Rome study (16%)

***Differences:*** Skills were reported as a key barrier only in the NI study, with 6% of barriers falling into this domain. All participants in the Rome study reported being confident cooks, even if they didn't like or cook certain foods, whereas, in the NI study, it was reported that those who couldn't cook generally were married men and those participants who reported that they didn't like certain foods, were not confident in cooking them.

### **Opportunity**

According to the COM-B model, for behaviour to occur, there must be a physical and social opportunity in the environment.

#### ***Physical Opportunity.***

***Similarities:*** Barriers relating to physical opportunity were the most commonly reported barriers in both the NI and Rome populations, with 29% of all utterances falling into this component in both studies. The TDF domain related to this component is environmental context and resources.

#### ***Environmental context and resources.***

This domain is defined as any circumstance of a person's physical environment or situation that could support or hinder the development of skills and abilities, E.g. budget, time, doesn't cook or shop, availability of quality foods.

***Similarities:*** The work environment was reported as a barrier to eating the MIND diet foods by both NI and Italian samples. It was reported that canteen food can be unhealthy and that there is the temptation to eat more quantity of food. Several participants reported that if they didn't have lunch with them, they would eat out in a café or buy lunch from a bakery which would be unhealthier.

***Differences:*** Time was a major barrier reported by both samples, particularly for those that were in employment, however, their reasons for *time* being a barrier differed. For the NI participants, it was more a matter of convenience that they had been working all day, having maybe taken children to after school activities, and didn't have the *time* to cook with fresh foods. The Italian population reported *time* as barrier in the same manner, but also, the *time* to travel to access fresh food in the farmers markets in the country, especially for those living in the city.

Budget was also reported as a major barrier to buying several of the MIND diet foods such as fish, berries and nuts in both populations. However, this was only the view of those participants in low paid jobs or unemployed in the NI sample. Several participants from the Italian sample, who are all professional or skilled workers, reported *budget* to be a barrier, especially with regards to fish and wholegrains.

Treats such as cakes and sweets in the home and workplace were reported as being a major barrier in adhering to the MIND diet in the NI sample. Participants reported that having *treats* in the house for guests and children would hinder them in adhering to the MIND diet as they often eat the *treats* themselves. Also, NI participants reported that *treats* in the workplace were common, that there were always biscuits available and that this would be a hindrance to adhering to the MIND diet. However, treats in the workplace were not reported by the Italian sample, in fact, when asked if biscuits were commonly found in the workplace, participants reported that it is only on occasion that biscuits or treats were offered at work, such as, someone's birthday.

A major barrier reported by the Italian sample and a key difference between both samples, was access and availability of certain foods of the MIND diet. Most Italian participants reported that the availability of berries out of season were scarce. One participant reported that, Italy provides so many different, tasty fruit, that why would they choose berries that are hard to find and expensive. Several participants also reported that wholegrains were expensive and hard to find. Italian participants also reported that access to fresh fruit, vegetables and fish may hinder them in adhering to the MIND diet, especially those that lived in the city of Rome.

Participants reported that the fish and produce in the city is more expensive and poor quality than in the country and that they would consume less fruit and vegetables, and fish because of this. In contrast, the NI sample reported that the fruit and vegetables are more expensive and of poorer quality in the country and small towns, and that they would have to travel to the bigger stores to access cheaper better-quality food.

Another facilitator reported by both samples in order to help in adhering to the MIND diet was to bring their lunch to work. Participants reported, that in order to consume the MIND diet at work, they would need to bring their own lunch to prevent them from eating out. Many participants from the Italian sample already brought a healthy lunch to work which facilitated them in adhering to the MIND diet.

### ***Social opportunity***

***Similarities:*** Social opportunity was reported as being a key barrier and facilitator in both NI and Italian samples, with 13% of all facilitators and 5% of barriers falling into this component from the NI sample and 15% of all barriers and 12% of facilitators from the Italian sample. The TDF domain related to this component is social influence.

***Social Influence:*** This domain is described as the “*interpersonal processes that can cause individual to change their thoughts, feelings or behaviours, which may be due to social pressure, norms, social/family support or peer pressure*” [38]

***Similarities:*** A key barrier reported by both samples was visiting family/friends. Both samples reported that either going out to visit friends or family coming to visit resulted in eating unhealthier and more quantity. However, the NI sample reported eating more fast foods, while the Italian sample reported cooking more unhealthily, such as lasagne, cheese and pasties and more quantity.

Family support/influence was reported as a key facilitator by both samples. Participants from NI sample reported that they felt their family would support them if they were to uptake the MIND diet.

***Differences:*** Another key barrier under this domain which was only reported by the Italian sample, was *lack of family support/influence*. Participants often reported avoiding certain foods such as wholegrains or eating less healthy foods such as vegetables, as other family members didn't like them. Also, several participants reported that their family would not support them in this diet, particularly those who originate from the South of Italy, where eating more food and more unhealthily is typical of their culture.

### **Motivation.**

Motivation is a component of the COM-B model and there must be strong motivation for the behaviour to occur. Motivation can be divided into “reflective” or “automated”.

#### ***Reflective Motivation.***

***Similarities:*** Reflective motivation involved self-conscious planning and evaluations. (Beliefs about what is good or bad). Participants reported reflective motivation to be a barrier to the uptake of the MIND diet and 18% of barriers fell into this component of the COM-B model, compared to 15% in the NI study. More facilitators were reported under this domain with 33% from the NI sample and 37% from the Rome sample.

***Belief about capabilities:*** The extent to which the individual believes they are able to adhere to the MND diet.

***Similarities:*** Taste preference was reported as a major barrier to the adherence of the MIND diet in both the NI and Italian populations. Participants reported not liking various elements of the diet such as fish, vegetables and chicken. However, many of the participants in the Italian sample reported not liking wholegrains, in particular, wholegrain pasta or bread and even if they did like it, they would not buy it as their children didn't eat it.

Convenience was also reported as a barrier to the uptake of the MIND diet in both samples. Both samples reported cooking less healthy food to suit their children and eating it themselves rather than making two meals for *convenience*.

Mindset was reported by both samples as a barrier to the uptake of the MIND diet. The NI sample reported that being in the right mindset was important to change diet and to be determined to do so. However, the Italian sample reported the difficulty they perceived in reducing certain foods, such as cheese. Many Italian participants reported that they would not be able to do this.

**Differences:** Belief about Capabilities was also reported as being a major facilitator in the uptake of the MIND diet with 16% of all barriers falling into this domain in both samples. While both samples reported that being organised and prepared when cooking meals or having lunch prepared for work was a facilitator, the Italian participants reported that the MIND diet seemed similar to their own diet and would be easy to follow. They also reported that the MIND diet allowed for simple meals such as pasta and vegetables which is quick and easy to make.

**Professional, Social and Identity:** How the individual views the uptake/maintenance of the MIND diet relative to their identity. (e.g. parent, culture)

**Differences:** Culture was reported as both a barrier (3%) and a facilitator (7%) under this domain from the Italian study only. Participants reported that the MIND diet was similar to their own diet and the Mediterranean diet. Participants reported that as they ate most of these foods, that this would help them adhere to the MIND diet. They also reported that butter is not part of their diet, they only use olive oil which further supports uptake of the MIND diet. However, most participants reported that not only were berries hard to find out of season, but they were not part of their culture. Some participants also reported that wholegrains were not part of their culture and it would not be acceptable to serve wholegrains to family and friends. It was also reported that cheese is a big part of the Italian culture and reducing cheese would be difficult to do.

**Belief about consequences:** This domain is described as, anticipated outcomes of not eating brain healthy foods, anticipated or experienced outcomes of eating brain healthy foods. (positive or negative). Belief about consequences was reported as a major facilitator in both samples with it being the most reported facilitator in the NI sample (17%). Both samples reported that if they adhered to the MIND diet, they believed it would be good for their overall health, less sleepy and improve mental health. However, some of the Italian participants recognised that with more fibre from the wholegrains and less cheese, that this would have a benefit for their bowels and cholesterol.

### **Automatic Motivation**

*"Automatic motivation involves wants and needs, desires, impulse and reflex responses"[40].*

### **Emotion**

**Similarities:** Both samples reported that they would feel positive about following the MIND diet with 7% of facilitators falling into this domain in the Italian sample and 9% in the NI sample. However, similar to NI participants, even though participants felt positive about the MIND diet, this did not necessarily coincide with their intention to uptake the diet.

### **Mapping of barriers and facilitators to intervention functions and behaviour change techniques**

This study sought to identify intervention functions that are likely to be effective in facilitating change in MIND diet behaviour. We found that 5 of the 9 intervention functions suggested by the BCW were most relevant to the COM-B behavioural analysis conducted in this study. The 5 intervention functions were: education (increasing knowledge), training (imparting skills), persuasion (influencing attitudes and actions), enablement (providing support to overcome barriers) and environmental restructure (to provide cues and prompts for desired behaviour) [37]. These intervention functions were considered most likely to bring about change in MIND diet behaviour in midlife. The Behaviour Change Technique Taxonomy v1 (BCTTv1) [49], was used to identify which behaviour change techniques would best serve the COM-B behaviour analysis and the selected intervention functions. Fifteen BCTs were identified as likely to be effective in delivering the intervention functions and bringing about change in MIND diet behaviour. Therefore, capability to promote adoption of the MIND diet will be addressed by offering demonstration and instruction on how to perform the behaviour. Opportunity to promote adoption of the MIND diet will be addressed by adding objects to the environment, prompts/cues, remove aversive stimuli and social support. Motivation to promote adoption of the MIND diet will be addressed by a range of self-regulatory BCTs such as goal setting, problem solving, self-monitoring, action planning and information on health consequences.

## Discussion

This is the first study to describe a cross cultural theory-based qualitative approach exploring barriers and facilitators to the uptake of the MIND diet to inform an intervention. Results found that 85% of Italian barriers fell into 6 of the TDF domains compared to 80% from the NI study and 85% of Italian facilitators fell into 7 of the TDF domains compared to 80% in 6 TDF domains in the NI study.

Similar to the NI study, the Italian key barriers reported were: environmental context and resources, belief about capabilities, behaviour regulation and knowledge. However, skills, and memory, attention and decision processes were not reported as key barriers in the Rome population. Instead, social influence and social, professional and identity were reported as key barriers to the uptake of the MIND diet. Key facilitators reported were environmental context and resources, belief about capabilities, belief about consequences, social influences, skills and emotion. The Italian population reported one further facilitator which was social, professional and identity. Our results confirmed previous research finding regarding commonly reported barriers and facilitators to adherence to healthy dietary change, including *budget* [50], *time* and *taste preference* [51] and *family influence* [52].

Similar to the NI population, the Italian sample reported having no knowledge of the MIND diet prior to the study and what constituted brain healthy food. Nicklas et al. [53] found that lack of knowledge regarding dietary recommendations and health benefits were reported as a key barrier in meeting dietary recommendations, and lack of information on healthy food was also reported as a major barrier [54].

Participants from both samples reported lack of monitoring their food intake which further highlights “capability” as a barrier to uptake of the MIND diet. Previous research found that behaviour regulation was associated with changes in dietary outcomes [55] and more specifically, self-monitoring was associated with a positive change in diet [56,57]. Self-monitoring is shown to not only increase awareness of eating patterns [58,59], but also allows professionals to identify food aversions/intolerances and poor food choices [59].

Opportunity was highlighted as a key barrier to the uptake of the MIND diet with 48% of all barriers falling into this domain in the Italian sample compared to 29% in the NI sample. The difference in percentages between the two samples is due to social influences being reported as a barrier in the Italian sample but not the NI sample. Environmental context and resource was a major theme to emerge with “Time” being a key factor in both samples, mainly reported by those who led busy lives. This finding supports previous research that found “Time” to be a barrier to eating a healthy diet [60,61]. Busy lifestyle was found to be associated with less home cooked meals [52] and poorer eating habits (62–64).

“Budget” was also found to be a significant barrier in both samples, which was mainly due to the healthy elements of the MIND diet, such as fish, wholegrains, berries and nuts. These findings support previous research that found the cost of food to be a significant factor in people’s choice of food and consumption [65] and that higher adherence to a whole dietary pattern such as the Mediterranean Diet, had higher cost associated with the healthy elements of the diet (fish, fruit, vegetables, nuts) and lower cost to the unhealthy elements of the diet (processed meat and sweet) [52,66]. These findings are further supported in Roa et al. [67] that found unhealthy processed foods to be less expensive than fruit, vegetables and nuts. However, Roa et al. [67] explained that the higher cost could be offset by reducing the amount of unhealthy food consumption. Further support for this was found in Germani et al. [68] who compared the cost of a 4-member family with the cost of the same family following the Mediterranean Diet and found that the cost of the Mediterranean Diet was slightly higher in the overall budget. However, following an increase in the budget for healthy foods such as fruit and vegetables and reducing the budget for unhealthy foods such as processed meat and sweets, the overall budget for both diets were similar. It was therefore concluded that low adherence to the Mediterranean Diet was not associated with cost but rather a difference in allocating money to different food groups.

Access and availability of fresh food was reported as both a barrier and facilitator in both samples. However, the Italian sample reported it as a major barrier compared to the NI sample and for different reasons, mainly due to seasonal foods being unavailable and limited access to fresh foods reported by those living in the city. One interesting difference between the two samples under this barrier is that in NI, there is cheaper, better quality food in the bigger stores and cities. However, it was reported that it is in the country markets in Rome that cheaper, fresher food is found. The literature generally supports that access to fresh cheaper foods is

a barrier in rural areas. Previous research found that shops selling healthier food was a long distance from country communities [69,70] and that limited access to food resources led to poorer dietary habits [71].

However, in line with our findings with the Italian sample, previous research found that those who had access to farmers markets or grew their own food, was a facilitator to healthy eating [72]. However, the Italian sample further reported that farmers markets only open in the morning which did not suit those who worked. This finding is supported in Smith et al. [73], that found farmers markets to have inconvenient times and low frequency. Barnridge et al. [74] found that participants reported eating the recommended daily fruit and vegetables when receiving nutrition education and access to a garden. However, those who received no nutrition education but access to the garden, did not report eating the recommended fruit and vegetable, suggesting that it is knowledge not access to the garden that was related to an increase in fruit and vegetable consumption.

Social influence was reported as a barrier to the uptake of the MIND diet by the Italian sample only, and as a facilitator by both samples. Family influence was reported as key barrier in the Italian sample. This may be due to the Italian sample being influenced by their children with 73% of the sample having children in the home compared to only 28% of the NI study. The Italian sample often reported that their children would not eat certain elements of the MIND diet such as wholegrains or vegetables, influencing their decision to buy or cook such foods. This finding is supported in the literature that the taste preference of family and friends is a barrier to healthy eating [52]. Furthermore, research found the preference of children and family to be an important barrier when adopting a healthier lifestyle, particularly with increasing consumption of healthy foods. However, family support and influence were also reported as a key facilitator in adhering to the MIND diet, which is consistent with previous research that found family support was associated with healthier foods [75,76].

Motivation was highlighted as a barrier and facilitator to the uptake of the MIND diet in both samples with 18% (Italian) and 15% (NI) of all barriers falling into this COM-B component, and 37% (Italian) and 33% (NI) of all facilitators falling into this component.

A major barrier reported in both samples was belief about capabilities, with taste preference being a factor associated with adhering to the MIND diet. This finding is in line with previous research that found taste preference to be a barrier to healthy eating [52]. Morrow et al [77] found that men were more likely to eat healthily if they did not perceive taste to be a barrier. Many of the Italian participants reported that the MIND diet was very similar to their own diet and therefore, felt it would be quite easy to follow. Previous research found that level of education is associated with healthy eating [78–80] and the Italian sample are all educated with 76% of the Italian sample with a higher qualification compared to 36% of the NI sample with a higher qualification and 36% with no formal qualifications. Research found that level of nutritional knowledge is associated with length of education and awareness of food related issues, leading individuals to be more interested in a balanced dietary pattern [34,35]. However, the Italian sample perception of the MIND diet adherence ease may be attributable to their culture. The MIND diet is a Mediterranean style diet and many of the Italian participants reported following their cultural diet which is rich in fruit, vegetables, nuts, grains, and olive oil and that this in itself is a facilitator to adhering to the MIND diet. Research in the Mediterranean countries have found that the Mediterranean Diet is progressively disappearing [81,82]. However, research estimating adherence to the Mediterranean Diet in the Mediterranean countries using secondary data, found that Italy had the best adherence to the Mediterranean Diet [83]. Even though Italians had the best adherence to the Mediterranean Diet, it was still decreasing since the economic crisis [84].

Culture was also reported as a barrier to adhering to the MIND diet in the Italian sample only. Participants often reported that certain MIND diet foods were not typical of their culture and serving certain foods to family and friends were not acceptable, such as wholegrain pasta and bread. This finding is in support of previous research that found low consumption of wholegrains in a Spanish sample [85–86]. Baruth et al. [87], found family to be a barrier to healthy eating. It was reported in Baruth's study that women were pressurised to eat more and that they were not supported if they were trying to eat a healthy diet. Furthermore, the sample in Baruth's study was with African American women, and they may feel pressure to eat more, as food and the context of eating their traditional food is important to their cultural identity [87].

## Limitations

This study was undertaken in a small sample of Italian and Northern Irish men and women and our findings may be context based and, therefore, not generalisable to the whole population. However, generalisability was not the main aim of our study, rather to explore people's attitudes and perceptions towards the uptake and adherence to the MIND diet, with the aim to inform an

intervention. Researcher subjectivity may be seen as a limitation to our study; however, codes and themes were identified by a second researcher which suggest that the themes drawn have credence beyond interpretation of the lead researcher. Focus groups run the risk of introducing bias [88], resulting from an individual's desire to conform to social acceptability [89]. However, in this study, focus group participants were acquaintances, and therefore, may reduce the risk of social acceptability. Barriers and facilitators reported in this study are "perceived" and, therefore, may have limited value in predicting uptake of the MIND diet. Furthermore, half of the Italian participants spoke in Italian and some of the richness of the data may have been lost in translation. However, the second researcher (Italian) translated, transcribed and analysed the data to maximise interpretation and understanding of the data.

### **Strengths**

To our knowledge, this is the first study to develop a "behavioural diagnosis" of factors influencing the uptake of the MIND diet in a Mediterranean and non-Mediterranean country. This was the first study to apply the TDF to explore people's attitudes towards a whole dietary pattern and compare these attitudes between a Mediterranean and non-Mediterranean country. The COM-B model provides a more comprehensive explanation of adherence than existing models [23], making it easier to identify appropriate interventions. Moreover, this study used the COM-B model as an additional step in the thematic analysis, which increased the study's efficiency and showed that the entire framework was adequate for purpose.

### **Conclusion and Implications**

This paper presented a comprehensive "behavioural diagnosis", which provides a detailed account of factors that influence 40–55 years old capability, opportunity and motivation to adhere to the MIND diet, as a base for developing behaviour change interventions using the BCW.

The "behavioural analysis" in this study found that, although Italian participants reported no knowledge of the MIND diet, they acknowledged that the MIND diet was very similar to their own Mediterranean diet. Most of the Italian participants reported following the Med Diet which may be attributable to their age and education status. Barriers to healthy eating were evident in both samples, such as time, taste preference and convenience. However, more specific barriers to the MIND diet in the Italian sample were found including, culture, social influence and seasonal foods. These specific MIND diet barriers were not found in the NI sample. However, both samples reported similar barriers including self-monitoring, lack knowledge and access to fresh food.

The "behaviour diagnosis" has allowed us to explore and gain a deeper understanding of attitudes towards the MIND diet and has helped identify which barriers and facilitators can be targeted to improve adherence to the MIND diet. The results presented above suggest that there is potential to optimise all three components of the COM-B model to increase adherence to the MIND diet, highlighting the importance of addressing these factors when designing behaviour change interventions. In addition, the identification of intervention functions and BCTs has laid a strong foundation for the design and implementation of an effective intervention to promote adherence to the MIND diet at midlife. This evidence base will help the development of a theoretically driven framework to guide health practitioners, policy makers and researchers in the design of multifaceted behaviour change interventions across cultures.

## **Declarations**

### **Ethics approval**

Ethical approval was obtained from the Staff and Postgraduate Filter Committee, which is in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

### **Consent for publication**

All participants provided written informed consent before participating in the study, which included consent to publish anonymous quotes from individual participants.

### **Availability of data and material**

The dataset (individual transcripts) is not publicly available due to confidentiality and ethical reasons.

## Competing Interests.

The authors declare they have no competing interests.

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The Department for the Economy (DfE) sponsored the research for this paper.

## Authors contributions

DT/BG led the study and conducted all the interviews/focus groups. DT/BG also analysed, coded and interpreted the data. DT wrote the manuscript. ES was also closely involved with data analyses and coding of the data. ES, JMcC, AP, MG, EA, DC revised the manuscript critically for intellectual content. All authors read and approved the final manuscript.

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## Tables

**Table 1:** *Interview/focus group questions asked to participants in accordance with the TDF and COM-B model.*

COM-B	TDF	QUESTION
Psychological Capability	Knowledge.	What is your understanding of the MIND diet?
Psychological Capability	Memory, attention and decision processes.	To what extent is eating a diet to promote brain health something you normally do? 1. Prompt: Do you eat foods that promote brain health each day
Psychological Capability	Behaviour regulation	To what extent do you monitor whether you are eating foods that promote brain health?
Physical Capability	Skills	To what extent are you confident in cooking/eating a diet that promotes brain health?
Social Opportunity	Social influences	To what extent do/would your family or friends help or hinder you eating a diet that promote brain health? 1. Prompt: Does/would your family support you in eating a diet that promotes brain health?
Physical Opportunity	Environmental context and resources.	Discuss anything in your work or/and home environment that might help or hinder you eating foods that promote brain health? E.g budget, time
Reflective Motivation	Social/Professional role and identity	To what extent would eating a diet that promotes brain health be accepted by your friends and family? 1. Prompt: Do you think your family/friends influences what you eat?
Reflective Motivation	Belief about capabilities	How difficult/easy would it be for you to eat a diet that promotes brain health? 1. Prompt: What are the barriers to consuming a diet that promotes brain health? 2. Prompt: What are the facilitators to consuming a diet that promotes brain health?
Reflective Motivation	Optimism	To what extent are you confident that any barriers you may have to eating a diet that promotes brain health can be solved?
Reflective Motivation	Intention	To what extent do you intend to follow the MIND diet to promote brain health?
Reflective Motivation	Goals	To what extent would you like to follow the MIND diet?
Reflective Motivation	Belief about consequences	What do you think will happen if you eat a diet to promote brain health? 1. Prompt: Discuss any benefits to eating a diet that promotes brain health?
Automatic Motivation	Reinforcement	To what extent are there any incentives for you to eat a diet that promotes brain health?
Automatic Motivation	Emotion	How do you feel about eating a diet to promote brain health?

COM-B: Capability (C): Psychological or physical ability to enact behaviour; Opportunity (O): Physical and social environment that enables behaviour. Motivation (M): Reflective or automatic mechanisms that activate or inhibit behaviour; Behaviour (B). TDF: Theoretical Domains Framework.

**Table 2:** Participant characteristics of both Rome and NI sample.

Characteristic		Percentage of sample (n=25)	
		ROME	NI
Age 40-55 years		100	100
Gender			
	Male	36	40
	Female	64	60
Occupation			
	Professional	64	44
	Skilled	36	16
	Unskilled	0	40
Education			
	Higher education	72	36
	Further education	28	28
	No formal	0	36
qualifications			
Marital status			
	Married	60	44
	Co-habiting	20	4
	Separated	12	4
	Single	8	32
	Widowed	0	4

Education: Level of education obtained within a discipline or profession. N=50

**Table 3:** *Barriers and facilitators in rank order of utterances in relation to MIND diet in 40-55-year olds in Rome and NI: COM-B and TDF domains*

<b>BARRIERS</b>	<i>ROME</i>	<i>Northern Ireland</i>
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COM-B	TDF	Rank order	Frequency of Utterances	% of utterances.	COM-B	TDF	Rank order	Frequency of utterances	%of utterances
Physical opportunity	Environmental context and resources	1	93	33	Physical opportunity	Environmental Context and resources	1	90	29
Social opportunity	Social Influence	2	43	15	Reflective motivation	Belief about capabilities	2	46	15
Reflective motivation	Belief about Capabilities	3	37	13	Psychological capability	Knowledge	3	37	12
Psychological capability	Behaviour regulation	4	29	10	Psychological capability	Memory, attention, Decision making	4	30	10
Psychological capability	Knowledge	5	29	10	Psychological capability	Behaviour regulation	5	24	7
Reflective motivation	Social, Professional and Identity	6	15	5	Physical capability	Physical skills	6	17	6
	Belief about consequences	7	11	4		Social	7	15	5
	Skills	8	9	3		Belief about consequences	8	12	4
	Intention	9	9	3		Social professional and identity	9	12	4
	Optimism	10	7	2		Intention	10	9	3
	Emotion	11	4	2		Optimism	11	6	2
X	X	X	X	x		Goals	12	5	2
X	X	X	X	X		Emotion	13	3	1
X	X	X	X	x		Reinforcement	14	1	0
			286	100				307	100

<b>FACILITATORS</b> COM-B	TDF	Rank order	Frequency of utterances	% utterances	COM-B	TDF	Rank order	Frequency of utterances	Percentage of utterances
Physical opportunity	Environment context	1	48	21	Reflective motivation	Belief about consequences	1	28	17
Reflective motivation	Belief about Capabilities	2	36	16	Reflective motivation	Belief about capabilities	2	27	16
Reflective motivation	Belief about consequences	3	32	14	Physical opportunity	Environmental Context and resources	3	22	13
Social opportunity	Social	4	28	12	Social Opportunity	Social influence	4	21	13
Physical capability	Skills	5	19	8	Physical capability	Skills	5	20	12
Reflective motivation	Identity	6	16	7	Automatic motivation	Emotion	6	15	9
Automatic motivation	Emotion	7	16	7		Reinforcement	7	10	6
	Optimism	8	10	4		Intention	8	6	4
	Intention	9	10	4		Behaviour regulation	9	4	2
	Re-enforcement	10	7	3		Optimism	10	4	2
	Regulation	11	4	2		Social/Professional and identity	11	3	2
	Attention	12	3	1		Knowledge	12	3	2
	Knowledge	13	2	1		Memory	13	1	1
			231	100				164	100

Information above the thick black line represents the top 6 reported domains of the TDF and corresponding COM-B components. Eighty percent of the data fell into the top 6 TDF domains; COM-B: Capability (C): Psychological or physical ability to enact behaviour; Opportunity (O): Physical and social environment that enables behaviour. Motivation (M): Reflective or automatic mechanisms that activate or inhibit behaviour; Behaviour (B). TDF: Theoretical Domains Framework.

Utterances: Spoken word/words in relation to themes/subthemes emerging from questions asked regarding MIND diet.

n=50

**Table 4:** Quotes from barriers regarding uptake of the MIND diet

<i>Northern Ireland</i>			<i>Rome</i>		
COM-B/TDF	SUB-THEME	QUOTE	COM-B/TDF	Subtheme	QUOTE
Physical opportunity: Environmental context	<ol style="list-style-type: none"> <li>1. Time</li> <li>2. Food environment at work/canteen</li> <li>3. Budget</li> <li>4. Treats in for kids.</li> </ol>	<p>“For me it is time, by the time you get home from work, and maybe have done overtime, you couldn’t be bothered”</p> <p>“There is nothing healthy in a canteen”</p>	Physical opportunity: Environmental context	<ol style="list-style-type: none"> <li>1. Availability/ Access to food</li> <li>1. Budget</li> <li>2. Time</li> <li>3. Season</li> </ol>	<p>“Finding berries and the cost of them are a barrier”</p> <p>“Berries are hard to find as they are seasonal, I only eat them in summer”</p>
Reflective motivation: Belief about capabilities	<ol style="list-style-type: none"> <li>1. Convenience</li> <li>2. Taste preference</li> <li>3. Mindset</li> </ol>	<p>“Kids don’t want healthy stuff, so sometimes I have convenience stuff to make it easier for me”</p> <p>“I don’t like fish, you know the strong smelling fishy fish”</p>	Reflective motivation: Belief about capabilities.	<ol style="list-style-type: none"> <li>1. Taste preference</li> <li>2. Convivence</li> <li>3. Mindset</li> </ol>	<p>“I don’t buy the brown pasta as it is more expensive and it doesn’t taste as nice as the white”</p> <p>“I don’t eat vegetables, any kind of them”</p> <p>“I love cheese, I do not think I could eat less cheese”</p>
Psychological capability: Knowledge	<ol style="list-style-type: none"> <li>1. Lack knowledge of MIND diet and foods</li> </ol>	<p>“If you don’t know what is healthy for your brain, you won’t eat that way”</p>	Social opportunity: Social influence	<ol style="list-style-type: none"> <li>1. Family influence</li> <li>2. Visiting family And friends</li> </ol>	<p>“The problem is my family, they only eat white pasta”</p> <p>“I would cook more unhealthily and quantity if family are visiting”</p>
Psychological capability: Memory, attention and decision process	<ol style="list-style-type: none"> <li>1. Alcohol</li> <li>2. Tired</li> <li>3. Holidays</li> </ol>	<p>“If I had a good drink at the weekend, it would take Tuesday or Wednesday to get over it, and I wouldn’t want to eat this food”</p>	Psychological capability: Behaviour regulation	<ol style="list-style-type: none"> <li>1. Self-monitoring</li> </ol>	<p>“No, I don’t monitor my food intake”</p>
Psychological capability: Behaviour regulation	<ol style="list-style-type: none"> <li>1. Lack monitoring of food consumption</li> </ol>	<p>“No, I don’t, and sure, when I go to weight watchers, I don’t even do it”</p>	Psychological capability: Knowledge	<ol style="list-style-type: none"> <li>1. Lack knowledge of MIND diet.</li> </ol>	<p>“I have never heard of the MIND diet”</p>
Physical capability: Skills	<ol style="list-style-type: none"> <li>1. Lack cooking skills</li> </ol>	<p>“I couldn’t cook that, if you handed me all the ingredients, I would be like, what am I doing with it”</p>	Social, professional and identity.	<ol style="list-style-type: none"> <li>1. Culture</li> </ol>	<p>“My family eat lots of food, lots of white pasta and cheese, this is typical of Southern Italians to eat more and are more overweight”</p> <p>“Berries are not part of our culture”</p>

COM-B: Capability, Opportunity, Motivation, Behaviour. TDF: Theoretical domains framework

**Table 5.** Quotes from participants regarding facilitators of uptake of the MIND diet.

<i>Northern Ireland</i>			<i>Rome</i>		
COM-B/TDF	SUBTHEME	QUOTE	COM-B/TDF	SUBTHEME	QUOTE
Reflective motivation: Belief about consequences	<ol style="list-style-type: none"> <li>1. Feel better generally</li> <li>2. Improve psychological health</li> <li>3. Improve memory</li> </ol>	<p>"I think the diet would just help you feel better generally"</p> <p>"And even help your head, less stress and worry"</p>	Physical Opportunity: Environmental context and Resources	<ol style="list-style-type: none"> <li>1. Bring lunch</li> <li>2. Time</li> </ol>	<p>"Here I bring lunch every day, it is very simple for me to prepare my salads so not a barrier"</p> <p>"Having the time to travel to get better quality food would be a facilitator".</p>
Reflective motivation: Belief about capabilities	<ol style="list-style-type: none"> <li>1. Planning/ preparation/ organisation</li> </ol>	<p>"Organisation and preparation the night before, so having your berries and salad ready for work"</p>	Reflective motivation: Belief about capabilities	<ol style="list-style-type: none"> <li>1. Normal diet</li> <li>2. Simple meals</li> <li>3. Organisation</li> <li>4. Motivation</li> </ol>	<p>"sometimes it is easier for all the family if you can cook it quickly, like pasta and veg"</p> <p>"If you were motivated enough, I think you could overcome your barriers".</p> <p>"I think you need to plan and be motivated".</p>
Physical opportunity: Environmental context and resources	<ol style="list-style-type: none"> <li>1. Accessibility fresh/frozen food</li> <li>2. Bring lunch to work</li> </ol>	<p>"I would go to Lidl, because it is cheaper and better quality"</p> <p>"In my work, you need to be prepared and bring lunch with you"</p>	Reflective motivation: Belief about consequences	<ol style="list-style-type: none"> <li>1. Overall health</li> <li>2. Cholesterol</li> <li>3. Lose weight</li> <li>4. Fiber/bowel</li> </ol>	<p>"I think this diet could help you gain more health"</p> <p>"I think my bowels would work better on this diet"</p> <p>"I think with eating less cheese would be good for your cholesterol"</p> <p>"I think you could lose weight on this diet"</p>
Social opportunity: Social influence	<ol style="list-style-type: none"> <li>1. Family support/influence</li> </ol>	<p>"My mum is always cutting out articles showing me research on good and bad foods for your health.</p>	Social opportunity: Social influence	<ol style="list-style-type: none"> <li>1. Family support/ influence</li> </ol>	<p>"Yes, my wife would support me if I wanted to do this diet"</p> <p>"yes, I think if I was out with family, there would be more alcohol, unhealthy foods and less veg"</p>
Physical capability: Skills	<ol style="list-style-type: none"> <li>1. Confident cook</li> </ol>	<p>"I am pretty confident cooking these foods"</p>	Physical capability: Skills	<ol style="list-style-type: none"> <li>1. Confident cook</li> </ol>	<p>"Yes, I cook generally the same legumes, I don't like beans very much so I don't cook them often, but I am able to cook them"</p>
Automatic motivation: Emotion	<ol style="list-style-type: none"> <li>1. Positive</li> </ol>	<p>"I would be positive about it, I get excited trying new things"</p>	Professional, social and identity Reflective motivation	<ol style="list-style-type: none"> <li>1. Culture</li> </ol>	<p>"this is typical foods for me, this would not be difficult for me"</p> <p>"we don't eat butter, it is not in our culture, we use olive oil"</p>
			Automatic motivation Emotion	<ol style="list-style-type: none"> <li>1. Positive</li> </ol>	<p>"I would feel positive about doing this diet"</p>

COM-B: Capability, Opportunity, Motivation, Behaviour. TDF: Theoretical domains framework

## Figures

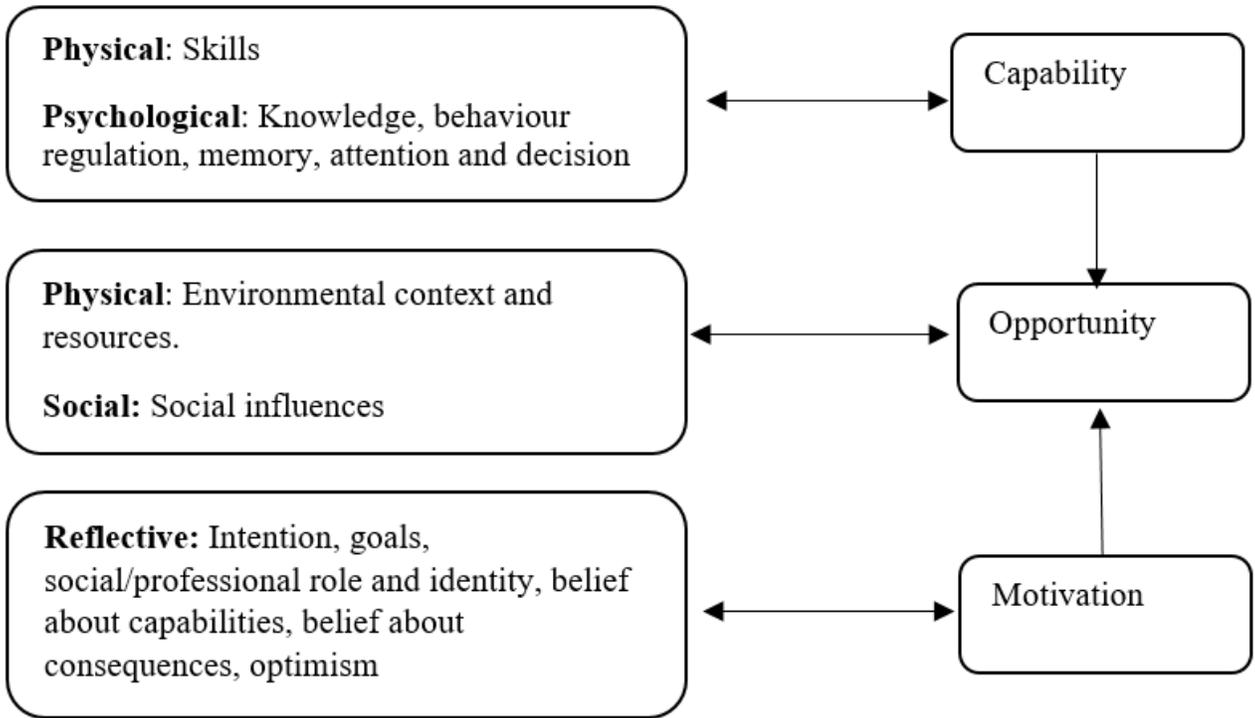


Figure 1

TDF domains and corresponding mapping onto the COM-B component [37]