

Artikel Ulasan/Review Articles

Dietary Polyphenols Consumption and Its Relation with Cognitive and Mental Health in Aging: A Review

(Pengambilan Polifenol Dietari dan Hubungannya dengan Kognitif dan Kesihatan Mental dalam Penuaan: Suatu Ulasan)

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ABSTRACT

Literature review suggests that polyphenols in particular flavonoids, are beneficial for mental health during aging process. This review examines the effect of consumption of all polyphenols groups on mental health and cognitive status during aging process. The keywords searched were “mental health,” “depression,” “anxiety,” “stress” and “cognitive” combined with “dietary,” and “polyphenols.” The databases including PubMed, Web of Science and CAB Abstracts were searched for a period of 10 years. A total of 11 studies were identified to fulfill the inclusion criteria. From this review, polyphenols may confer beneficial effects towards mental health, in particular the decline in cognitive functions during aging process, however, some studies showed contradictory results. Polyphenols have been proven to improve language and verbal ability, which is among the main vulnerable aspects in cognitive decline in pathological brain aging. In contrast, polyphenols intake did not seem to affect executive functioning. The effects of polyphenols towards cognitive status were more prominent among the elderly as compared to young and middle-aged adults. This review also shows that flavonoids is the main type of polyphenols that confer positive effects towards cognitive status during aging. This review provides evidence that consumption of polyphenols may lead to cognitive and mental health benefits. Further clinical trials involving human subjects are required with carefully designed methodology to elucidate the potential mechanisms underlying the relationship between polyphenols consumption and improvement in cognitive and mental health status.

Keywords: Polyphenols; mental health; cognitive status; aging; flavonoids

ABSTRAK

Kajian kepustakaan mencadangkan polifenol terutamanya flavonoid, bermanfaat untuk kesihatan mental semasa proses penuaan. Artikel ulasan ini mengkaji kesan pengambilan semua kumpulan polifenol terhadap kesihatan mental dan status kognitif semasa proses penuaan. Kata kunci yang digunakan adalah “kesihatan mental,” “kemurungan,” “keimbangan,” “stres” dan “kognitif” disertakan dengan “dietari” dan “polifenol.” Pangkalan data PubMed, Web of Science dan CAB Abstracts telah digunakan dan carian kajian 10 tahun yang lepas telah dijalankan. Sejumlah 11 kajian telah dikenal pasti memenuhi kriteria kemasukan. Daripada kajian ini, polifenol menunjukkan kesan manfaat terhadap kesihatan mental, terutamanya pengurangan fungsi kognitif semasa proses penuaan. Walau bagaimanapun, sesetengah kajian menunjukkan keputusan yang sebaliknya. Polifenol terbukti meningkatkan kemampuan bahasa dan verbal, yang merupakan aspek penurunan kognitif yang paling terdedah di dalam patologi penuaan otak. Sebaliknya, pengambilan polifenol tidak mempengaruhi kefungsi eksekutif. Kesan polifenol terhadap status kognitif lebih menonjol di kalangan warga tua berbanding golongan muda dan pertengahan usia. Kajian ini turut menunjukkan flavonoid adalah jenis polifenol utama yang memberi kesan positif terhadap status kognitif semasa penuaan. Kajian ini membuktikan pengambilan polifenol mampu memberikan kesan manfaat terhadap kesihatan mental dan kognitif. Kajian klinikal yang seterusnya membabitkan subjek manusia dengan metodologi yang disusun secara sewajarnya adalah diperlukan bagi menunjukkan mekanisme hubungan pengambilan polifenol dan penambahbaikan status kognitif dan kesihatan mental.

Kata kunci: Polifenol; kesihatan mental; status kognitif; penuaan; flavonoid

INTRODUCTION

Due to current environment, more middle-aged adults are exposed to some form of psychiatric morbidity, which include stress, depression, anxiety and declined cognitive functioning. Psychiatric morbidity has been identified as one of the health problems among middle-aged adults (Aziz

et al. 2008) that should be given appropriate attention in the current Malaysian healthcare system as 11.2% of adults were found to have some form of psychiatric morbidity (Third National Health and Morbidity Survey 2006). As Malaysia progresses from a developing country towards a developed status and with greater rural-urban migration and urbanization of its population, mental health disorders

among middle-aged adults is bound to increase in the coming years. Urban life has often been blamed for creating isolating anomic environments with high suicide rates.

Various factors had been identified to be associated with these problems including family, financial, social, health and work commitments. These problems should not be taken lightly as it would burden and increase the financial expenditure in the healthcare system. In addition, family institution will be affected while social problems including suicide rates are expected to increase as well.

Decline in mental health status has led to increasing prevalence of suicide and other social problems in this age group (Hayati & Kamarul 2008). Many studies identify mood disorders (particularly depression) as the most frequent disorder in person who commits suicide, affecting from 30% to 70%.

Among the risk factors for poor mental health among middle-aged and elderly individuals are generally similar to those for other groups, and include unemployment, isolation, poor health, pain, depression, alcoholism, low self-esteem, feeling rejected and a history of mental illness (Hayati & Kamarul, 2008). In addition, external factors/events include socio-economic conditions, family and other relationships, the physical or organisational environment may have an impact on the individual as well as his/her own intrinsic factor such as physical health or coping skills.

Recently, researchers have been studying the association of mental health and dietary factor, in particular polyphenols intake. This review aims to present latest scientific evidence regarding the improvement and reversion of mental health problems with regards to polyphenols intake in humans.

MATERIALS AND METHODS

SEARCH STRATEGY

A search strategy has been carried out in selected database using Medical Subject Heading [MeSH] and title abstract [tiab] terms. The keywords searched (including all MeSH, headings, subheadings, and tiab terms) were “mental health,” “depression,” “anxiety,” “stress,” and “cognitive” combined with “dietary,” and “polyphenols.” The databases including PubMed, Web of Science (http://isiwebofknowledge.com/products_tools/multidisciplinary/webofscience/), and CAB Abstracts (<http://www.cabi.org/cababstracts>) were searched for a period of 10 years from 2003 to 2013. Titles and available abstracts were scanned for relevancy, and articles requiring further consideration were identified.

Study Selection Criteria Studies were selected for inclusion in the review process if they met the following criteria:

1. Study design: randomized clinical trial and cross-sectional/restrospective studies. Animal studies were excluded from this review.

2. Population: Adult individuals identified as having depression, anxiety, stress and decline in cognitive functions.

Studies involving elderly individuals with dementia were excluded from this review.

RESULTS

After performing the keywords search, a total of 1111 articles or studies were identified. Eleven studies met the inclusion criteria involving 8211 adults (Table 1).

Three out of 11 studies examines polyphenols-rich fruit juice whilst two studies assess the effects of tea, coffee, wine and chocolate simultaneously, chocolate, tea and overall polyphenols/flavonoids intake, respectively, on mental health among samples from various age groups. Most of the studies were randomized-controlled studies, however, cross-sectional and longitudinal studies were also included in this review.

DISCUSSION

Table 1 shows that out of the eleven studies selected for this review, three studies examined the effect of polyphenols-rich fruit juice supplementation towards cognitive status. Supplementation of grape juice (6 – 9 mL/kg body weight/day) for 12 weeks improved verbal memory acquisition among older adults (mean age 78 ± 5 years). However, no improvement on delayed verbal and spatial memory was observed (Krikorian et al. 2010). In another study by Crews et al. (2005), subjects aged 69 ± 6 years were supplemented with 32 ounces of cranberry juice for twice a day. Supplementation was given for 6 weeks with 25 subjects in supplementation and placebo group respectively. No significant effects of cranberry juice supplementation on cognitive status were observed. This may be due to shorter supplementation period i.e. 6 weeks as compared to 12 weeks supplementation (Krikorian et al. 2010). In addition, the effect of improvement in cognitive status after supplementation may be more prominent in elder adults (Krikorian et al. 2010) as compared to their younger counterparts (Crews et al. 2005). In a study by Hendrickson and Mattes (2008) which examines the acute effect of grape juice supplementation on cognitive and mental health status of young adults (aged 26 ± 7.5 years), subjects were supplemented with grape juice containing 2100 mg/L total phenolics as gallic acid equivalents. A total of 17 men and 18 women who smoked at least 3 cigarettes per day participated in this study. They were assessed for mood, implicit memory, appetite and food intake before and after consuming the juice. They were administered with standardized lunch. They also ate similar breakfast (self-reported) and fasted for three hours before arrival. This study is among the limited number of studies which examine the acute effects of polyphenols intake

TABLE 1. Summary of studies assessing the relationship of polyphenols intake and mental health status during aging

References	Study populations	Polyphenol sources and dosage	Designs	Outcomes
Pase et al. (2013)	72 healthy middle-aged individuals	Participants received a dark chocolate drink mix standardized to contain 500 mg, 250 mg or 0 mg of polyphenols (placebo) in a parallel-groups design.	Participants consumed their assigned treatment once daily for 30 days. Cognition was measured with the Cognitive Drug Research system and self-rated mood with the Bond-Lader Visual Analogue Scale. Participants were tested at baseline, at 1, 2, 5 and 4 h after a single acute dose and again after receiving 30 days of treatment.	After 30 days, the high dose of treatment significantly increased self-rated calmness and contentedness relative to placebo. Mood was unchanged by treatment acutely while cognition was unaffected by treatment at all time points.
Kesse-Guyot et al. (2012)	2574 middle-aged adults with mean age 65.3 ± 4.6 years		Polyphenol intake was estimated by using at least six 24-hours dietary records collected in year 1994-1996 and cognitive performance was assessed in 2007-2009 using four neuropsychological tests: phonemic and semantic fluency, the RI-48 Cued Recall test, the Trail Making test, and Forward and Backward Digit Span. Inter-correlations among the test scores were estimated with principal component analysis.	In multivariate models, high total polyphenol intake was associated with better language and verbal memory ($P = 0.01$) but not with executive functioning ($P = 0.09$). More specifically, intake of catechins ($P = 0.001$), theaflavins ($P = 0.002$), flavonols ($P = 0.01$), and hydroxybenzoic acids ($P = 0.0004$) was positively associated with language and verbal memory, especially with episodic memory assessed by the RI-48 test. In contrast, negative associations between scores on executive functioning and intake of dihydrochalcones ($P = 0.01$), catechins ($P = 0.01$), proanthocyanidins ($P = 0.01$), and flavonols ($P = 0.01$) were detected. High intake of specific polyphenols, including flavonoids and phenolic acids, may help to preserve verbal memory, which is a salient vulnerable domain in pathological brain aging.
Feng et al. 2010	716 Chinese adults aged ≥ 55 years		A longitudinal study which reported current tea consumption habits (frequency and type) by the subject themselves. Cognitive performance was assessed by a battery of neuropsychological tests; composite domain scores on attention, memory, executive function, and information processing speed were computed using raw test scores. The Mini-Mental State Examination (MMSE) total score was used as a measure of global cognitive function.	After adjusting for potential confounders, total tea consumption was independently associated with better performances on global cognition ($B = 0.055$, $SE = 0.026$, $p = 0.03$), memory ($B = 0.031$, $SE = 0.012$, $p = 0.01$), executive function ($B = 0.032$, $SE = 0.012$, $p = 0.009$), and information processing speed ($B = 0.04$, $SE = 0.014$, $p = 0.001$). Both black/oolong tea and green tea consumption were associated with better cognitive performance. There was no association between coffee consumption and cognitive function.

continued

TABLE 1. *Continued*

References	Study populations	Polyphenol sources and dosage	Designs	Outcomes
Krikorian et al. (2010)	8 men, 4 women, mean age 78±5 years	Subjects were supplemented with Concord Grape Juice (Welsh's) for 6 –9 mL/kg body weight divided over 3 servings for 12 weeks.	This study is a randomized-controlled trial with the placebo were matched for appearance, taste, carbohydrate and energy. A total of 5 subjects were assigned to receive grape juice supplementation whilst 7 participants were given placebo.	Intake group had significantly better verbal memory acquisition as compared to placebo group at 12 weeks intervention period. No significant effect on delayed verbal memory and spatial memory.
Nurk et al. (2009)	2031 participants (70–74 y, 55% women)		Subjects reported their dietary habits using food frequency questionnaire. Cognitive test battery included the Kendrick Object Learning Test, Trail Making Test, part A (TMT-A), modified versions of the Digit Symbol Test, Block Design, Mini-Mental State Examination, and Controlled Oral Word Association Test.	Participants who consumed chocolate, wine, or tea had significantly better mean test scores and lower prevalence of poor cognitive performance than those who did not. Participants who consumed all 3 studied items had the best test scores and the lowest risks for poor test performance. The associations between intake of these foodstuffs and cognition were dose dependent, with maximum effect at intakes of ~10 g/d for chocolate and ~75–100 mL/d for wine, but approximately linear for tea. Most cognitive functions tested were influenced by intake of these 3 foodstuffs. The effect was most pronounced for wine and modestly weaker for chocolate intake.
Scholey et al. (2009)	30 healthy adults, aged 18-35 years	520 mg, 994 mg chocolate flavonoids (CF) and a matched control.	In this randomized, controlled, double-blinded, balanced, three period crossover trial, subjects consumed drinks containing 520 mg, 994 mg CF and a matched control, with a three-day washout between drinks. Assessments included the State Anxiety Inventory and repeated 10-min cycles of a Cognitive Demand Battery comprising of two serial subtraction tasks (Serial Threes and Serial Sevens), a Rapid Visual Information Processing (RVIP) task and a 'mental fatigue' scale, over the course of 1 h.	Consumption of both 520 mg and 994 mg CF significantly improved Serial Threes performance. The 994 mg CF beverage significantly speeded RVIP responses but also resulted in more errors during Serial Sevens. Increases in self-reported 'mental fatigue' were significantly attenuated by the consumption of the 520 mg CF beverage only. This is the first report of acute cognitive improvements following CF consumption in healthy adults.

continued

TABLE 1. *Continued*

References	Study populations	Polyphenol sources and dosage	Designs	Outcomes
Hendrickson & Mattes (2008)	17 men and 18 women who smokes at least 3 cigarettes per day, mean age 26.0±7.5 years	Subjects were supplemented with Concord grape juice (Welch's) containing 2,100 mg/L total phenolics as gallic acid equivalents. A total of 10 mL/kg body weight of grape juice or placebo was administered.	This is a placebo controlled, double blind test examining the acute effect of grape juice supplementation. Placebo was matched for energy, fructose, glucose, acidity, taste, colour and aroma against grape juice. Subjects were assessed for mood, implicit memory, appetite and food intake before and after drink. Test drink was administered with standardized lunch. Participants ate similar breakfast (self-reported) on each day, and fasted for 3 hours before arrival.	No acute effects of grape juice consumption on mood, implicit memory, appetite or food intake among young smokers.
Rogers et al. (2008)	48 healthy adult university students	Subjects were randomly assigned to receive either 250 g caffeine, 200 g theanine, both or neither of these	Ratings on mood, anxiety and alertness and blood pressure measured before and starting 40 minutes after drug administration.	Caffeine increased self-rated jitteriness and blood pressure. Theanine antagonised the effect of caffeine on blood pressure but did not affect jitteriness, alertness and other aspects of mood. Theanine also slowed overall reactance time on the visual probe task
Letenneur et al. (2007)	1,640 subjects aged 65 years and older free from dementia		Reliable dietary assessments were reexamined four times over a 10-year period. Cognitive functioning was assessed through three psychometric tests (Mini-Mental State, Examination, Benton's Visual Retention Test, "Isaacs" Set Test) at each visit. Information on flavonoid intake was collected at baseline.	After adjustment for age, sex, and educational level, flavonoid intake was associated with better cognitive performance at baseline ($p = 0.019$) and with a better evolution of the performance over time ($p = 0.046$). Subjects included in the two highest quartiles of flavonoid intake had better cognitive evolution than did subjects in the lowest quartile. After 10 years' follow-up, subjects with the lowest flavonoid intake had lost on average 2.1 points on the Mini-Mental State Examination, as compared to 1.2 point lost among subjects with the highest quartile. This gradient persisted after adjustment for several other potential confounders.

continued

TABLE 1. *Continued*

References	Study populations	Polyphenol sources and dosage	Designs	Outcomes
Kuriyama et al. (2006)	1003 Japanese subjects aged ≥ 70 years		Subjects completed a self-administered questionnaire that included questions about the frequency of green tea consumption. Researchers evaluated cognitive function using the Mini-Mental State Examination with cutoffs of <28 , <26 , and <24 and calculated multivariate - adjusted odds ratios (ORs) of cognitive impairment.	Higher consumption of green tea was associated with a lower prevalence of cognitive impairment. After adjustment for potential confounders, the ORs for the cognitive impairment associated with different frequencies of green tea consumption were 1.00 (reference) for ≤ 3 cups/wk, 0.62 (95% CI: 0.33, 1.19) for 4–6 cups/wk or 1 cup/d, and 0.46 (95% CI: 0.30, 0.72) for ≥ 2 cups/d (P for trend = 0.0006). Corresponding ORs were 1.00 (reference), 0.60 (95% CI: 0.35, 1.02), and 0.87 (95% CI: 0.55, 1.38) (P for trend = 0.33) for black or oolong tea and 1.00 (reference), 1.16 (95% CI: 0.78, 1.73), and 1.03 (95% CI: 0.59, 1.80) (P for trend = 0.70) for coffee. The results were essentially the same at cutoffs of <28 and <24 .
Crews et al. (2005)	50 adults aged ≥ 60 years, mean age 69 ± 6 years	Subjects were supplemented with 32 ounces cranberry juice for twice a day. There was no information regarding the dosage of polyphenols given. No details of polyphenol dose.	This is a 6 weeks double blind study with the placebo matched for appearance, taste, smell and vitamin C content. A total of 25 subjects received cranberry juice whilst 25 subjects received placebo. Subjects were administered a series of neuropsychologic tests including intelligence assessment at both pretreatment baseline and again after 6 weeks of supplementation.	No significant effects of cranberry juice on the subjects' intelligence were observed.

among young adults. No changes on the parameters were observed. This may be due to the short period of time for the polyphenols to work and these young adults may be robust to the effect of polyphenols as compared to older adults.

A total of six studies which examined the effect of chocolate, wine and green tea towards cognitive and mental health status were identified. In a study by Rogers et al. (2008), caffeine was shown to increase self-rated jitteriness and blood pressure whilst theanine antagonised the effect on blood pressure. Subjects consisted of 48 healthy university students and ratings on mood, anxiety, alertness and blood pressure were measured before and after 40 minutes of intake. This result showed the positive effect of tea on blood pressure, however, from this study, tea does not provide any effect towards mental health aspect i.e. jitteriness, alertness and mood. Studies by Kuriyama et al. (2006) Nurk et al. (2009) and Feng et al. (2010) examined the effects of long-term tea consumption among elderly individuals. Intake of tea was assessed by using food frequency questionnaire, whilst, series of cognitive test were carried out to examine their mental health status. Older adults who consumed tea on regular basis were shown to have better cognitive performance. In contrast, coffee did not improve any cognitive test batteries (Feng et al. 2010). This positive effect of long-term tea intake is in contrast with the study by Rogers et al. (2008) which previously examined the effect acutely and among young adults. The difference may be due to the effect of tea is more significant if it is consumed on long-term basis and among elderly individuals.

A study by Nurk et al. (2009) examined the effect of intakes of chocolate and wine towards cognitive performance among elderly subjects. Subjects who consumed these foods had significantly lower prevalence of poor cognitive performance than those who did not. The effects were dose-dependent, with maximum effects were observed at 10 gram/day and 75 – 100 mL/day for chocolate and wine, respectively. The effect was more prominent for wine and modestly weaker for chocolate intake.

A study by Pase et al. (2013) showed that treatment of high dose of polyphenols from dark chocolate drink mix for 30 days significantly increased self-rated calmness and contentedness relative to placebo. Acute testing was also conducted with mental health parameters were measured at baseline, and at 1, 2.5 and 4 hours after single dose. Mood were found to be unchanged after acute treatment whilst cognition was unaffected by treatment at all time points. In addition, a study by Scholey et al. (2009) also showed the beneficial effect of chocolate intake towards mental health. Intake of 520 and 994 mg of chocolate flavonoids by healthy young adults were shown to improve cognitive level. Both studies showed the beneficial acute effect of chocolate towards mental health status.

Letenneur et al. (2007) studied the association of total flavonoid intake with cognitive performance among elderly subjects. After adjustment for age, sex and educational

level were considered, flavonoid intake was associated with better cognitive performance at baseline and after 10-years follow up. In addition, a study by Kesse-Guyot et al. (2012) had shown strong association of polyphenols intake, in particular catechins, theaflavins, flavonols and hydroxybenzoic acid with language and verbal memory. However, no association was observed with executive functioning.

From this review, polyphenols may confer beneficial effects towards mental health, in particular the decline in cognitive functions during aging process, however, some studies showed contradictory results. More clinical trials need to be conducted before any conclusions are made. Polyphenols are proven to improve language and verbal ability, which are among the main vulnerable aspects in cognitive decline in pathological brain aging. In contrast, polyphenols intake does not seem to affect executive functioning. The effects of polyphenols towards mental health is more prominent among the elderly as compared to young and middle-aged adults. This review also shows that flavonoids is the main type of polyphenols that confer positive effects towards mental health during aging.

CONCLUSION

This review provides evidence that consumption of polyphenols may lead to cognitive and mental health benefits. Current researches show that polyphenols confers positive effects towards certain cognitive domains. Further clinical trials involving human subjects are required with carefully designed methodology to elucidate the potential mechanisms underlying the relationship between polyphenols consumption and improvement in cognitive and mental health status.

The body of literature regarding polyphenols intake and its association with cognitive and mental health status continue to grow, but, because of the methodological limitations and the small size of many of the studies, making inferences and generalizing results from individual trials are problematic. Most of the studies involved the elderly population with regards to their cognitive ability, however, more researches are currently being conducted among the middle-aged population. In addition, most of the study designs are cross-sectional, whilst only few studies involved clinical and randomized controlled-trials. Most of the polyphenols sources are familiar among the Western population, such as berries, chocolate, wine, coffee, with exception of green tea. Tropical fruits such as pomegranate, guava and roselle should be given prior attention in this research field as well.

ACKNOWLEDGEMENT

We would like to thank the Malaysian Ministry of Ministry of Science, Technology and Innovation (06-01-02-SF0764)

and Ministry of Higher Learning (LRGS/BU/2012/UKM) for their financial support throughout this research.

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Received: January 2014
Accepted for publication: May 2014