New technologies for timely, accurate and efficient detection of dementia and related disorders

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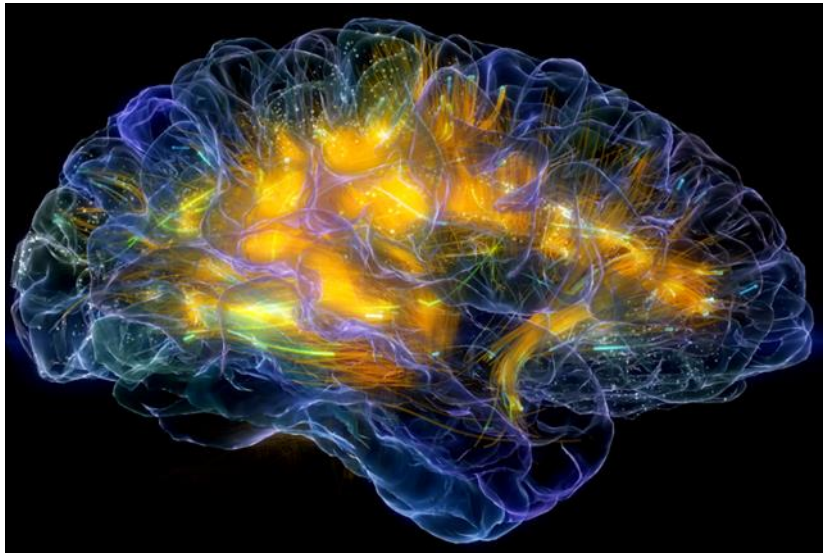
Background

Dementia and technology

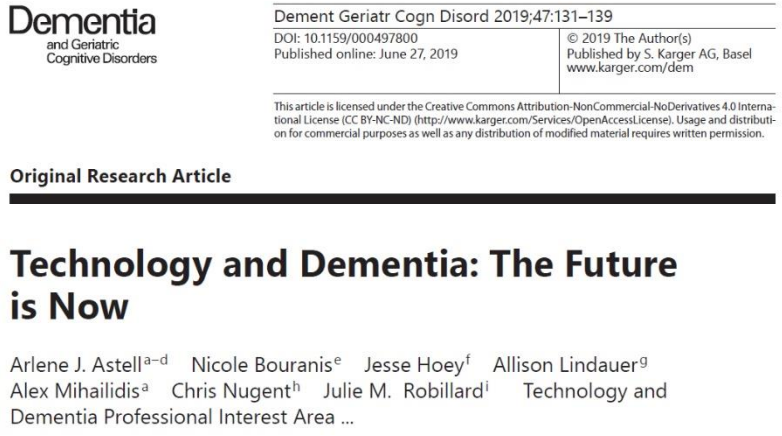


Dementia and technology

50% of dementia cases remain **undiagnosed**

Older adults represent the **fastest growing group** of technology users

The scientific community is placing an increasing emphasis in the role of **technology** in the fight against dementia



Dementia
and Geriatric
Cognitive Disorders

Dement Geriatr Cogn Disord 2019;47:131–139
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Original Research Article

Technology and Dementia: The Future is Now

Arlene J. Astell[a–d] Nicole Bouranis[e] Jesse Hoey[f] Allison Lindauer[g] Alex Mihailidis[a] Chris Nugent[h] Julie M. Robillard[i] Technology and Dementia Professional Interest Area ...

Timely detection of cognitive decline in the hospital

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Detection at the **Mild Cognitive Impairment** (MCI) stage

- Patients retain their **everyday functionality**
  - Can **live alone** without a caregiver
- Allows for timely **specialist assessment** and **care planning**

Computerized cognitive tests*

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- Standardized administration
- Can be use by non-specialists (nurses/ family doctors)
- Adaptation to the ability level of the examinee
- Enhanced precision of measurement and scoring

* Zygouris S, Tsolaki M. Computerized cognitive testing for older adults: a review. Am J Alzheimers Dis Other Demen. 2015 Feb;30(1):13-28. doi: 10.1177/1533317514522852

Computerized testing in Greece: our aims

Tech	• Development of a **fully-automated** MCI screening **test** for use in various settings
Model	• Design of **new practices** for the most efficient use of new screening tests
People	• Assessment of **attitudes** of healthcare personnel towards computerized screening tests and identification of barriers to implementation
System	• **Implementation studies** in hospital and primary care settings

PhD study aims

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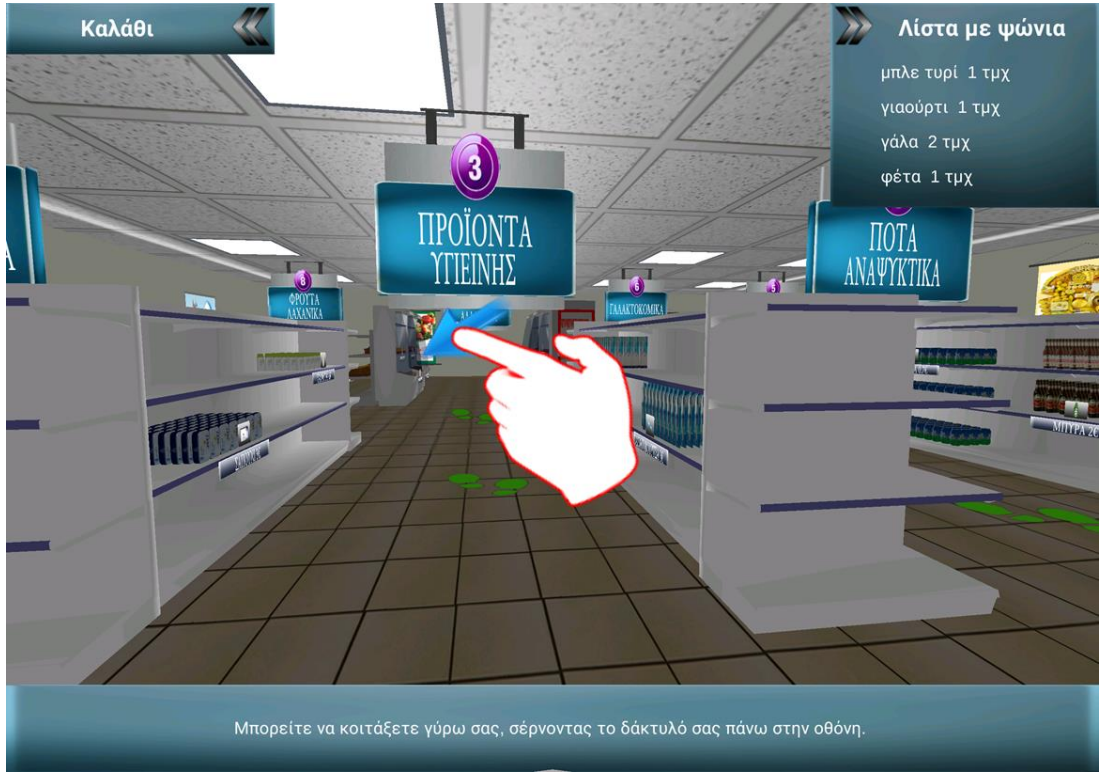
Creation and validation of a fully-automated self-administered computerized test for MCI detection

- Easy to use
- Can detect pre-clinical dementia
- Improved diagnostic accuracy VS existing tests

Assessment of attitudes of Greek nurses from public general hospitals towards the use of new technologies to detect dementia

- Overall nurses' attitudes
- Willingness to devote time and effort for training and use of new technologies
- Obstacles to implementation of novel technological solutions in general hospital environments

The Virtual Supermarket Test (VST)



VST overview

Purpose

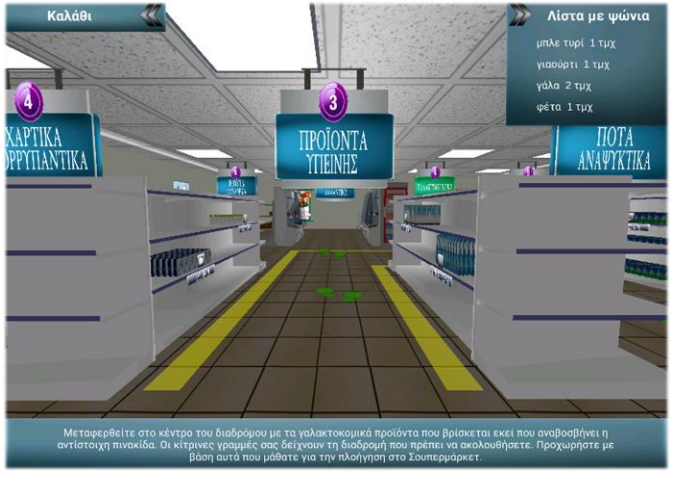
- Self-administered MCI screening test based on a brain training game
- Administration time: 20-30 minutes

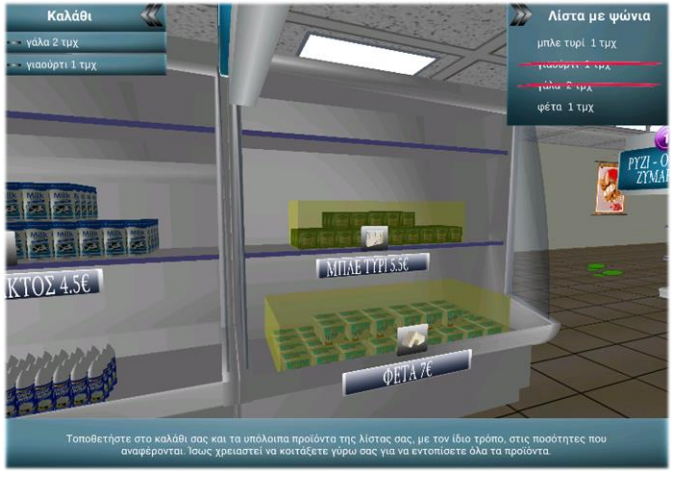
Structure

- Based on a virtual supermarket task
- Interactive training session
- 3 test sessions (one scenario repeated 3 times)

Rationale

- Navigation and executive function are impaired in MCI patients and this will be reflected in their performance





VST
performance metrics

Time

- Average completion time for the training session
- Average completion time for the 3 test sessions

Mistakes

- Incorrect products/ Incorrect quantities
- Incorrect payment amount

Trajectory & navigation

- Deviation from optimal trajectory/ navigation score
- Time spent on each waypoint

Practice effects

- Practice effect across the 3 test sessions

Greek VST studies

Journal of Alzheimer's Disease

Published on *Journal of Alzheimer's Disease* (https://www.j-alz.com)

12 January 2015

A virtual reality brain training game can detect mild cognitive impairment, a condition that often predates Alzheimer's disease

Thessaloniki, Greece – Greek researchers demonstrated the potential of a virtual supermarket cognitive training game as a screening tool for patients with mild cognitive impairment (MCI) among a sample of older adults. MCI is a condition that often predates Alzheimer's disease (AD) and is characterized by memory loss and inability to execute complex activities such as financial planning.

So far virtual reality game–based applications and especially virtual supermarkets have been used as cognitive training applications and as measures of cognitive functions, although it has been shown that they can detect MCI only when used in combination with standardized neuropsychological tests. However scientists from the Aristotle University of Thessaloniki (AUTH), the Greek Association of Alzheimer's Disease and Related Disorders (GAADRD) and the Centre for Research and Technology Hellas/Information Technologies Institute (CERTH/ITI) have succeeded in making the shift to MCI screening via robust virtual reality game applications that can be used on their own for accurate MCI detection. In an article published in the Journal of Alzheimer's Disease, the researchers have indicated that the virtual supermarket (VSM) application displayed a correct classification rate (CCR) of 87.30%, achieving a level of diagnostic accuracy similar to standardized neuropsychological tests, which are the gold standard for MCI screening. Patients with MCI can live independently and not all such patients progress to AD. Therefore the global effort against cognitive disorders is focused on early detection at the MCI stage.

Journal of Alzheimer's Disease

Published on *Journal of Alzheimer's Disease* (https://www.j-alz.com)

23 February 2017

Mild cognitive impairment, a condition that often predates Alzheimer's disease, can be remotely detected through a self-administered virtual reality brain training game

ARISTOTLE UNIVERSITY OF THESSALONIKI

Thessaloniki, Greece – Greek researchers demonstrated the potential of a self-administered virtual supermarket cognitive training game for remotely detecting mild cognitive impairment (MCI), without the need for an examiner, among a sample of older adults. MCI patients suffer from cognitive problems and often encounter difficulties in performing complex activities such as financial planning. They are at a high risk for progressing to dementia however early detection of MCI and suitable interventions can stabilize the patients' condition and prevent further decline.

1st VST study: proof of concept*

55 participants (21 healthy/ 34 MCI)

- Administration by specialist
  - Classification based on one administration after a structured training session

Correct classification rate (CCR): 87.3%

- Sensitivity: 82,35 %
- Specificity: 95.24 %

* Zygouris S, Giakoumis D, Votis K, Doumpoulakis S, Ntovas K, Segkouli S, Karagiannidis C, Tzovaras D, Tsolaki M. Can a virtual reality cognitive training application fulfill a dual role? Using the virtual supermarket cognitive training application as a screening tool for mild cognitive impairment. J Alzheimers Dis. 2015;44(4):1333-47.

2nd VST study: self-administration*

12 participants (6 healthy/ 6 MCI)

- Self-administration at home
  - Initial demonstration of VST by study coordinator
  - Classification based on average performance over 20 administrations

Correct classification rate (CCR): 91,6%

- Sensitivity 94%
- Specificity 89%

* Zygouris S, Ntovas K, Giakoumis D, Votis K, Doumpoulakis S, Segkouli S, Karagiannidis C, Tzovaras D, Tsolaki M. A Preliminary Study on the Feasibility of Using a Virtual Reality Cognitive Training Application for Remote Detection of Mild Cognitive Impairment. J Alzheimers Dis. 2017;56(2):619-627.

Latest VST study: fully-automated app*

Aim

- Assessment of the diagnostic utility of the latest, fully self-administered, VST version

Sample

- 95 older adults (47 MCI/ 48 healthy) with subjective memory complaints

Protocol

- Administration of VST and gold standard screening tests
  - Mini Mental State Examination (MMSE)
  - Montreal Cognitive Assessment (MoCA)

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IOS Press

Detection of Mild Cognitive Impairment in an At-Risk Group of Older Adults: Can a Novel Self-Administered Serious Game-Based Screening Test Improve Diagnostic Accuracy?

Stelios Zygouris[a,b,*], Paraskevi Iliadou[c], Eftychia Lazarou[c], Dimitrios Giakoumis[d], Konstantinos Votis[d], Anastasios Alexiadis[d], Andreas Triantafyllidis[d], Sofia Segkouli[d], Dimitrios Tzovaras[d], Thrasyvoulos Tsiatsos[e], Sotirios Papagianopoulos[a] and Magda Tsolaki[a,c]
[a]*School of Medicine, Aristotle University of Thessaloniki, Greece*
[b]*Network Aging Research, Heidelberg University, Germany*
[c]*Greek Association of Alzheimer's Disease and Related Disorders, Thessaloniki, Greece*
[d]*Centre for Research and Technology Hellas/ Information Technologies Institute, Thessaloniki, Greece*
[e]*School of Informatics, Aristotle University of Thessaloniki, Greece*

Table 1
Demographic characteristics of participants

	SCD	MCI
Male/Female	10/38	12/35
Mean Age, y (Std. Err.)	65.96 (0.652)	67.89 (0.759)
Mean Education, y (Std. Err.)	13.67 (0.430)	12.87 (0.430)
Mean MMSE (Std. Err.)	28.88 (0.154)	28.04 (0.245)
Mean MoCA (Std. Err.)	27.98 (0.266)	25.34 (0.398)

SCD, subjective cognitive decline; MCI, mild cognitive impairment, Std. Err., standard error of mean.

* Zygouris S, Iliadou P, Lazarou E, Giakoumis D, Votis K, Alexiadis A, Triantafyllidis A, Segkouli S, Tzovaras D, Tsiatsos T, Papagianopoulos S, Tsolaki M. "Detection of mild cognitive impairment in an at-risk group of older adults: Can a novel self-administered serious game-based screening test improve diagnostic accuracy?". Journal of Alzheimer's Disease. 2020;78(1):405-412. DOI: 10.3233/JAD-200880

Results

81,91% correct classification rate for MCI detection

- Sensitivity: 76,27%
- Specificity: 91,43%

Higher CCR than MoCA and MMSE

- MoCA: 72,04% (sensitivity: 69,81% - specificity: 75%)
- MMSE: 64,89% (sensitivity: 63,64% - specificity: 66,67%)

Metrics used for classification

Supplementary Table 1. Virtual Supermarket Test variables used for classification

Average performance and learning variables	
DurAvg	Average duration for the 3 test trials
PosTimeYellow1-3	Time spent in yellow zone positions in trial one minus time spent in yellow positions in trial 3
Trial 1 variables	
Dur-Pos1	Duration minus time in positions during trial 1*
PosTimeGreen1	Time spent in green zone positions in trial 1
PosNumGreen1	Number of green zone positions the user navigated though in trial 1
PosTimeRed/Tot1	Time spent in red zone positions as a fraction of total time spent in positions in trial 1
PosNumRed/Tot1	Number of red zone positions the user navigated through as a fraction of total number of positions the user navigated through in trial 1
Trial 2 variables	
ErrMoney2	Incorrect payment in trial 2
PosNumYellow2	Number of yellow zone positions the user navigated through in trial 2
PosTimeYellow/Tot2	Time spent in yellow zone positions as a fraction of total time spent in positions in trial 2
Trial 3 variables	
PosNumTot3	Total number of positions the user navigated through in trial 3
PosNumGreen/Tot3	Number of green zone positions the user navigated through as a fraction of total number of positions the user navigated through in trial 3

* Essentially this variable expresses time spent in the payment screen

Conclusions

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The fully self-administered version of VST has good diagnostic utility

The CCR of the VST for MCI detection is 10% higher than the CCR of the MoCA which is considered a gold standard MCI screening test

Assessment of attitudes of nurses from public general hospitals towards computerized dementia screening

Attitudes of nurses towards computerized screening

Creation of 8-item questionnaire to assess attitudes of nurses towards computerized dementia screening and possible barriers to its implementation

Validation study in a sample of 212 undergraduate psychology students and assessment of attitudes of a very small sample of 19 nurses*

- Single factor structure
- Overall positive attitudes

Study to assess the attitudes of nurses towards computerized dementia screening

* Zygouris S, Gkioka M, Moraitou D, Teichmann B, Tsiatsos T, Papagianopoulos S, Tsolaki M. “Views of nursing staff on computerized dementia screening: A validation and pilot study in a general hospital”. Zeitschrift für Gerontologie und Geriatrie. DOI: 10.1007/s00391-019-01633-0

Questionnaire

1. Do you know that there are tests for the detection of dementia that are administered through a PC or tablet device?	
	O Yes O No

2. How desirable do you consider the following characteristics of computerized dementia screening tests?					
	Not at all	*A little*	*So-so*	*A lot*	*Very much*
Brief administration					
Ability to be administered by most members of staff (nurses/ doctors/ psychologists/ other healthcare personnel)					
Automated administration and scoring					
Embedded diagnostic algorithm					
Provision of information for care/ referral after the end of the examination					
Other: **……**					

3. How much time could you devote to be trained in the use of computerized dementia screening tests?	
	O Less than 4 hours O 4 – 8 hours O 1 – 2 days O 3 – 4 days O 1 week

4. How much time could you devote (during your shift) to examine an older adult with a computerized dementia screening test?	
	O Less than 5 minutes O 5 – 10 minutes O 10 – 20 minutes O 20 – 40 minutes O 40 – 60 minutes

5. How interested you would be in using tests that are administered to relatives of patients and to patients with a high level of functionality, and can be used autonomously by the examinee without your participation in the examination (self-administered tests)?				
Not at all	***A little***	***So-so***	***A lot***	***Very much***

6. Do you believe that older adults without serious memory issues and with good functionality would be interested in using a self-administered cognitive assessment test?				
Not at all	***A little***	***So-so***	***A lot***	***Very much***

7. Do you believe that relatives of older adult patients will be interested in using a self-administered computerized questionnaire where they will evaluate the everyday functionality of the patient before admission to hospital and receive information about the probability of the patient suffering from dementia?				
Not at all	***A little***	***So-so***	***A lot***	***Very much***

8. Which factors do you believe impede the integration of computerized screening tests in your hospital?	
	O Cost of equipment O Cost of software O Lack of training O Lack of a plan for their integration in the daily routine of the hospital O Time needed for staff training O Time needed for their use

Study to assess nurses' attitudes

Aim

- Assessment of attitudes of a large representative sample of Greek nurses

Sample

- 161 nurses from two public Greek general hospitals

Protocol

- Confirmatory factor analysis
- Assessment of attitudes

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IOS Press

Assessing the Attitudes of Greek Nurses Toward Computerized Dementia Screening

Stelios Zygouris[a,b,*], Mara Gkioka[a,b], Despina Moraitou[c], Birgit Teichmann[b], Thrasyvoulos Tsiatsos[d], Sotirios Papagianopoulos[a] and Magda Tsolaki[a,e]
[a]*School of Medicine, Aristotle University of Thessaloniki, Greece*
[b]*Network Aging Research, Heidelberg University, Germany*
[c]*School of Psychology, Aristotle University of Thessaloniki, Greece*
[d]*School of Informatics, Aristotle University of Thessaloniki, Greece*
[e]*Greek Association of Alzheimer's Disease and Related Disorders, Thessaloniki, Greece*

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Table 1
Demographic characteristics of participants

Age (y)	15–25	26–35	36–45	46–55	56–65
	1 (0.6%)	5 (3.1%)	38 (23.6%)	106 (65.8%)	11 (6.8%)
Work experience (y)	1–5	6–10	11–15	>15	
	5 (3.1%)	8 (5.0%)	17 (10.6%)	131 (81.4%)	

Results

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A two-factor structure was revealed

- Questionnaire assesses:
  - feasibility
  - acceptability
- Correlation between factors
- Double loading of an item on both factors

Confirmatory factor analysis

Factor 1: feasibility

- Questions describing desirable characteristics of computerized screening tests

Factor 2: acceptability

- Questions assessing how willing nurses, patients and relatives would be to use computerized screening tests
- Loading of an item from factor 1 that relates to automated administration and scoring

Table 3.1
The structure of the questionnaire: Standardized solution (2-Fb model)

Items	Factors			
	Fe (F1)	Ac (F2)	E	R
Q2a	0.464		0.886	0.215
Q2b	0.611		0.791	0.374
Q2c	0.763	0.196	0.550	0.698
Q2d	0.841		0.540	0.708
Q2e	0.734		0.679	0.539
Q5		0.610	0.792	0.372
Q6		0.705	0.709	0.497
Q7		0.800	0.600	0.840

Q2a, Question 2a; Q2b, Question 2b; Q2c, Question 2c; Q2d, Question 2d; Q2e, Question 2e; Q5, Question 5; Q6, Question 6, Q7, Question 7. Fe, Feasibility; Ac, Acceptability. Factor loadings are statistically significant ($p<0.05$).

Table 3.2
Factor and variable correlations

F1 – F2	0.259*
Q2a – Q2b	0.352*

*Correlation is significant at the $p<0.05$ level.

Nurses' attitudes

Overall positive attitude of nurses towards computerized dementia screening

- High overall score and score for each factor (similar to previous study)
- The majority of nurses were unaware of the existence of computerized screening tests (similar to previous study)

Nurses' attitudes

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Total questionnaire score = 30,85 (SD= 4,93)

- Total questionnaire score in previous study (nurses sample) = 29,50 (SD = 3,20)

Table 4
Factor score and total score

	N	Minimum	Maximum	Median	Mean	Std. Deviation
Factor 1 (Feasibility)	161	10	25	19	19.38	3.80
Factor 2 (Acceptability)	161	6	20	15	15.27	2.76
Total score	161	17	40	31	30.85	4.93

Barriers to implementation

Detailed recording of possible barriers to the implementation of computerized dementia screening in general hospitals

- Cost of equipment
- Lack of training (not mentioned in previous study)
- Lack of a plan for the integration of computerized screening tests in the daily routine of the hospital
- Time needed for staff training

Conclusions

The questionnaire measures two distinct aspects of attitudes toward computerized dementia screening (feasibility – acceptability)

Overall positive attitude of nurses towards computerized dementia screening

Initial data on possible barriers to the implementation of computerized dementia screening in Greek public general hospitals

PhD project overall results

Outcomes

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A new fully-automated self-administered computerized test was validated for use in a Greek population

This novel test outperforms established test in the detection of MCI in a population of older adults with cognitive concerns

Nurses appear willing to use computerized screening tests in general hospitals

First assessment of barriers to the implementation of computerized tests in Greek public general hospitals

Collaborations

Scientific collaborators

- University of Heidelberg Network Aging Research (NAR)
- Greek Association of Alzheimer's Disease and Related Disorders
- Centre of Research and Technology Hellas – Information Technologies Institute (CERTH/ ITI)
- University of California San Francisco Memory and Aging Center (UCSF MAC)

Funders

- Robert Bosch Stiftung
- Global Brain Health Institute & Alzheimer's Association

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Thank you

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