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LITERATURE REVIEW

The influence of educational status on motor performance and learning: a literature review

A influência da escolaridade no desempenho e no aprendizado de tarefas motoras: uma revisão de literatura

La influencia de la educación en el rendimiento y el aprendizaje de tareas motoras: una revisión de la literatura

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ABSTRACT | Many studies have shown the impact of the educational status on cognitive and motor control. However, few studies in the area of Physical Therapy and Motor Behavior consider the educational status of the subjects. This study aimed to describe evidences about the influence of the educational status on motor behavior (and its repercussions on physiotherapeutic assessment) and on motor learning (and its repercussions on physiotherapeutic treatment). We included in this review national and international studies from 1998 to 2013 from SciELO, MEDLINE and LILACS databases. We used the keywords: educational status, schooling level, motor control, motor behavior, motor performance, and motor learning. Sixty studies were located and 28 were selected, because they followed the inclusion criteria: (1) to investigate the effect of education on motor performance; (2) be available in Portuguese or English; and (3) be available in Brazil. The review showed that the educational status of patients must be considered by the physiotherapists in experimental and clinical practice, because many studies have shown its influence on assessment and treatment of young and older adults.

Keywords | Psychomotor Performance; Educational Status; Review.

RESUMO | Muitos estudos têm mostrado o impacto da escolaridade na cognição e motricidade. Porém, ainda poucos estudos na área de Fisioterapia e Comportamento Motor consideram a escolaridade da amostra. Este trabalho visou descrever evidências sobre a influência da escolaridade no comportamento motor (e suas repercussões na avaliação fisioterapêutica) e na aprendizagem motora (e suas repercussões no tratamento fisioterapêutico). Um levantamento de 1998 a 2013 buscou periódicos nacionais e internacionais nas bases de dados SciELO, MEDLINE e LILACS, com os descritores: escolaridade, nível educacional, controle motor, comportamento motor, desempenho motor e aprendizagem motora. Foram localizados 60 estudos. Desses, 28 foram selecionados por atenderem aos critérios de inclusão: (1) investigar o efeito da escolaridade sobre o desempenho motor; (2) estar em português ou inglês; e (3) estar disponível no Brasil. A revisão mostrou que a escolaridade dos pacientes deve ser considerada pelos fisioterapeutas em situações experimentais e clínicas, pois diversos estudos mostraram sua influência na avaliação e no tratamento de jovens e idosos.

Descritores | Desempenho Psicomotor; Escolaridade; Revisão.

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RESUMEN | Muchos estudios han demostrado el impacto de la educación en las habilidades cognitivas y motoras. Sin embargo, muy pocos estudios en el campo de la Terapia Física y Comportamiento Motor consideran la escolarización en la muestra. Este estudio tuvo como objetivo describir la evidencia sobre la influencia de la educación en el comportamiento motor (y sus efectos sobre la evaluación de terapia física) y aprendizaje motor (y sus repercusiones en la fisioterapia). Un sondeo 1998-2013 buscó revistas nacionales e internacionales en las bases de datos SciELO, MEDLINE y LILACS, utilizando las palabras clave: educación, nivel de educación, control de motores, el comportamiento del motor, el rendimiento del motor y de aprendizaje motor. Se localizaron 60 estudios. De éstos, 28 fueron seleccionados porque cumplen con los criterios de inclusión: (1) investigar el efecto de la educación sobre el rendimiento del motor; (2) estar en Portugués o Inglés; y (3) estará disponible en Brasil. La revisión mostró que la educación de los pacientes debe ser considerada por los fisioterapeutas en situaciones experimentales y clínicos, ya que varios estudios han demostrado su influencia en la evaluación y el tratamiento de jóvenes y ancianos

Palabras clave | Desempeño Psicomotor; Escolaridad; Revisión.

INTRODUCTION

A relevant phenomenon in developing countries is low level of school education. In Brazil, the time of school education is six years among adults and three years among elderly[1]. Learning how to read and write influences the functional organization of the human brain. Individuals with low educational status tend to present lower activation of cortical regions, basal ganglias, thalamus and cerebellum, in cognitive and motor tasks[2] and in the fusiform gyrus in perceptive tasks[3]. The low education changes the pattern of brain potentials and events[4] and the activation of the right hippocampus, posterior insula, thalamus and operculum[5] while performing memory related tasks. It also diminishes the metabolism f glucose in the performing of cognitive tasks in the posterior cingulate gyrus, precuneus[6], the lateral, middle and superior temporal gyrus and the medial temporal one to the left[7]. Among individuals with Alzheimer's disease, the low schooling level increases the negative effect (cognitive changes) of beta-amyloid concentrations in brain tissue[8].

Individuals with low school education level have more difficulties with tasks of visual perception (they are slower and make more mistakes), for example, when identifying two-dimensional representations of objects[9,10]. Also, they take longer and make more mistakes in tasks of pictures cancellation[11]. As for the cognitive skills, studies show worse performance in language, arithmetics and memory. Illiterate individuals showed worse performance in pseudo words repetition tasks than literate ones and presented greater difficulty during tasks of verbal fluency, calculation, monetary representation and word retention[9,12-14].

There are many studies on perceptive and cognitive differences caused by differences in schooling level, though few on motor differences. Neuropsychological tests used motor responses (speaking, writing, drawing), but the discussions tend to be centered in cognitive performance. On the other hand, many works which studied motor behavior ignored the educational status of the sample and do not discuss the possible influence of this trait over performance and learning. This work aimed at describing evidences on the influence of school education level on motor behavior (and their repercussions in Physical Therapy evaluation) and on motor learning (and its repercussions in Physical Therapy treatment).

METHODOLOGY

A bibliographic review of the last 15 years (1998 to 2013) was conducted, in both national and international journals, in the databases of SciELO, MEDLINE and LILACS. We used all combination between: educational status, schooling level, motor control, motor behavior, motor performance, motor learning.

All the articles and thesis which fulfilled the inclusion criteria were analyzed: (1) investigation of the effects of schooling on motor development; (2) written in Portuguese or English; and (3) to be available (print or digital format) in Brazil. Initially, 60 studies were located. From these, 28 were selected for having as a primary or secondary goal the investigation of the influence of school education on motor performance. The remaining ones were not included because they aimed at studying the influence of schooling level on perception (14 studies), on overall cognition, without considering the motor performance (11 studies), on the survival rate, income and/or quality of life (7 studies). Up next, the main results of the 28 selected studies are presented.

RESULTS

The studies found evidenced the effects of low schooling level in the decreased visual and motor abilities, lower ability and dexterity on motor tasks involving both upper and lower limbs[9,14-24]. In general, it was observed a greater difficulty of individuals with lower educational status on learning new movements[20]. Besides that, the studies reported that individuals with low schooling level showed precocious signs of cognitive and motor aging. They also described lower capacity of less educated individuals with in expressing their ideas both orally and in writing.

In general, less educated elderly had lower functional independence and less coordination and grip [23]. The studies also reported higher prevalence of alterations on the executive function[25] and dementia among less educated elderly[26-31]. The negative influence of low schooling was also described for the performance and cognitive and motor recovery of other diseases, such as head trauma[32], Parkinson's disease[33,34]. The influence of schooling on therapeutic approaches for the prevention of falls among healthy elderly was also mentioned[35].

DISCUSSION

The influence of low school education on motor performance and learning

The low education results in the decrease of visual and motor abilities, poorer dexterity and praxis ability. Individuals with low educational level have worse performance in the task of building replicas with cubes, from figures drawn[14], copies of figures[15,17] and clock drawing[9,18]. They also present worse performance in manual movements, such as imitating gestures, pushing buttons and placing opposing fingers[16,19-22].

Individuals with low education seem to adopt different strategies for execution and learning. Two strategies are used in order to help developing a movement. The first one is based on the visual analysis of the movement (sensorial), with the transformation of the visual information into a motor representation. The second one is based on the verbal interpretation of gesture (semantics) and it occurs when, for example, a verbal command is given for the movement. Individuals with high schooling level use both strategies when performing movements. However, the semantic strategy is more poorly elaborated among individuals with low schooling level, which makes them more dependent of visual strategies, resulting in flaws and lower scores in tests[16].

In an experiment which associated an identification visual task and comparison of pictures to a motor task of alternance in steps from the ground to a platform, individuals with low schooling had more difficulties on isolated tasks and more mistakes on the visual task, when this was performed simultaneously to the motor task[24]. They also had more difficulties in learning a sequence of finer oppositions movements, with more mistakes and lower speed in the trained sequence and more difficulty of learning generalization for a untrained task[20].

The influence of low school education on aging

Education has a protective effect against the loss of cognitive-motor performance by aging[25,26]. Individuals with low schooling present early cognitive aging. Women with different schooling level participated in a series of studies known as "the nun study", but only if they became nuns since they were young and kept similar living habits. Throughout the aging process, nuns with low schooling level had earlier worsening of coordination and manual grip strength, visual acuity, ability to express written ideas and functional independency[23].

Higher school education compensates the progression of the Alzheimer's disease and delays its clinical manifestations. The cognitive reserve theory proposes that education provides a cognitive and neurologic reservation, through neuronal changes or increase in efficiency of processing networks, thus, the clinical symptoms of degeneration due to Alzheimer's appear just later on[27-29]. There is a higher prevalence of dementia among elderly with low educational status[30].

The ability to inhibit a motor response, assessed by the Stoop test, worsens with aging in a more pronounced way among individuals with low schooling level[25]. Individuals with eight or more years of study have higher protection against the reduction of cognitive response[5,7,26]. These data were confirmed by studies with neuroimaging[3-7] and *post-mortem*[8,26,31], which demonstrated that, among individuals with dementia with the same clinical impairment and the same severity classification for the disease had lower number of neuropathological findings. The hypothesis

of compensation suggests that high schooling level may diminish cognitive decline up to a point at which basic skills Begin deteriorating with aging. At this moment, individuals with higher school education may present a faster progression of cognitive decline[27,29].

Besides studies on dementia, other studies approached the influence of low educational status on performance and on the recovery of other diseases. Walker *et al*.[32] assessed individuals with head trauma sequelae performing tasks of completing figures, codes, cubes, matrix reasoning, figures' arrangement, searching for symbols and setting up objects. There was an effect of age and school education level, with poorer performance among the elderly and among low schooling level[32]. Homann *et al*.[33] assessed individuals with Parkinson's disease in a task of pushing buttons in a keyboard as fast as possible, but without compromising precision, and they observed that elderly and low educated individuals presented slower speeds.

The reduction of functional balance and the increase of fall risk, which occur with aging, are aggravated by low schooling levels. Low educated elderly tend to have lower scores in Berg's balance scale and in the Timed Up and Go test. Also, individuals with higher scores in Berg's scale have better performance in the trail making test, which suggests a relation between balance and the executive function[34,35].

Hester *et al*.[36], Tombaugh[37] and Barnes *et al*.[38] studied the influence of age and school education on the trail making test. The interference of age and school education was not the same in parts A and B of the test. In part A, the simpler one, the performance worsened with the growing age, but did not suffer interference from education. In part B, the most complex one, the individuals suffered both the influence of age and schooling. Therefore, for individuals with low schooling level, there was a most pronounced decline of performance each decade of life[36-38]. Another study adapted the trail making test to be performed on wandering mats, instead of tracing the path on paper with a pencil. They observed that there was the same effect of age and schooling: elderly and lower educated individuals presented lower speed, especially in part B[39].

Gitlin *et al*.[40] investigated whether the differences in schooling level among elderly could result in distinct gain after a guidance program which aimed at minimizing disparities between physical capacity and environmental demand, with exercises of balance and muslce strengthening, protection reaction training and raising safely from the ground, in case of falls, ways of using tools, energy conservation and modifications in the house for greater safety. The performance was assessed after 6 and 12 months of intervention. The group with lower schooling level presented higher improvement over the group with higher school education. A possible explanation to this fact is the lower accessibility to this kind of information, as well as to resources on assisting locomotion and lesser knowledge about compensatory strategies[40].

Higher schooling levels are associated to better executive eficiency[13,25,29]. In a task which would involve inhibitory control and standard alternance to verbal response to sound stimulation, individuals with higher education presented performances similar to the ones of less diminish the influence of aging in cognitive and motor tasks.

Implications for Physical Therapy

In Physical Therapy practice and in clinical research, it is important to consider that individuals with low schooling level may become more tense during assessments[13] and thus reduce the speed in the assessed task due to greater fear of making mistakes[20,23], for not being so familiar with testing situations, which are frequent in school activities. Since verbal fluency and memory may be worse in individuals with low schooling levels[9,12], the anamnesis and guidance using visual information associated to verbal one may have more positive results than the use of exclusively verbal resources. There are studies showing better perception of individuals with low schooling level in the face of real objects or pictures rather than with two-dimensional schematics[10], thus, it is interesting, when transmitting orientation, to use this kind of resource.

When reproducing sequential movements, low educated people may have more difficulty, which could justify the solicitation of simplified motor sequences, or subdivided ones. Despite having difficulty in the execution, learning and generalization of motor tasks, low educated individuals improve their performance with training[20,24,38], therefore, it is interesting to train these activities.

Considering the physiological process of aging, it is important to consider that individuals with low educational level may be more dependent on daily life activities, have worse balance and lower locomotion speed[26,35,41-45]. Elderly individuals with low schooling have higher dependence of help to perform functional

activities[41]. According to Gregory *et al.*[42], low schooling is an independent predictor of the incidence of difficulties on mobility at pre-clinical level. It is important to monitor these individuals, verifying the demands on multiprofessional intervention that they may present. This group tends to have less Access to health treatments and orientations, as well as to resources of assistance to locomotion and less knowledge of compensatory strategies[40], therefore, they will be the individuals who will probably benefit the most from these interventions.

Finally, in the rehabilitation o f individuals with dementia[5,7,9,12,18,26-30], Parkinson's disease[33,34], head trauma[32] and stroke[46] it is important to consider the individual's educational level in order to choose the best assessment strategy, for several studies showed that the impact f brain injuries in functional independency is higher among individuals with low schooling level.

The overview of the work presented in this review is observed in Chart 1.

CONCLUSION

The educational level of patients must be considered by physical therapists in experimental and clinical situations, for several studies showed its influence on the assessment and treatment of youngsters and elderlies.

Chart 1. Main studies investigating the influence of schooling on motor performance

Authors (year)	Number of subjects	Age (years)	School education (years)	Tasks	Results
1. Souza *et al.*[34] (2013)	28 patients with Parkinson's disease 30 healthy elderly	60-80	G1:4-10 G2: 12-18	Berg's balance scale and trail making test	Elderly with LSE present worse performance on trail test; among individuals with Parkinson's disease, schooling impaired more than Just balance
2. Yong e Saito[41] (2012)	4968	≥65	G1: ≤8 G2: >8	Ability to perform daily living activities	Individuals with LSE have less years of active life (with functional independency)
3. Machado *et al.*[24] (2011)	30	20-59	G1: 1-5 G2: >10	Taking alternate steps from the ground to a platform (simple task) and identifying images on a screen (double task)	Individuals with LSE make more mistakes in visuals tasks, take less steps in motor tasks and have worse performance in double tasks
4. Gregory *et al.* [42] (2011)	436	70 a 79	G1: 0-8 G2: 9-11 G3: 12 G4: >12	Walking half a mile, climbing up steps, doing chores, getting up from bed and from a chair	Pessoas com EB têm mais risco de apresentar dificuldades nas tarefas avaliadas. EB é um preditor independente de dificuldades de mobilidade em nível pré-clínico
5. Hong *et al.*[17] (2011)	125	≥65	G1: IL G2: L	Copying overlapped pentagons and a cube	Idosos NA apresentam pior desempenho
6. Voos *et al.*[35] (2011)	101	60-80	3-16	Berg's balance scale and timed rising up and walking	Idosos com EB apresentam pior desempenho
7. Voos[39] (2010)	70	G1: 20-34 G2: 50-64 G3: 65-79	G1: ≤11 G2: ≥12	Ambulate as soon as possible on mats in a path formed by numbers (part A) and letters (part B)	Indivíduos mais idosos e com EB apresentam mais dificuldade (menor velocidade), sobretudo an parte B
8. Kim e Chey[18] (2010)	240 (healthy), 28 (mild dementia)	G1: 55-64 G2: 65-74 G3: 75-84	G1: ≤6 G2: ≥7	Performing the clock test	Escolaridade e doença influenciam no desempenho. Indivíduos com EB apresentam desempenho semelhante ao de indivíduos com demência leve
9. Walker *et al.* [32] (2009)	100 (with brain injury)	16-75	0-12	Completing figures, codes, cubes, matrices, arranging figures, looking for symbols ans setting up objects	Pior desempenho para os mais idosos e com EB
10. Ashendorf *et al.*[19] (2009)	307	55-74	G1: ≤12 G2: >12	Task of opposing fingers and Grooved pegboard test	A tarefa de oposição de dedos sofre influência da escolaridade (indivíduos com EB: pior desempenho), mas o *grooved pegboard test* não
11. Meijer *et al.* [45] (2009)	1344	G1: 24-47 G2: 49-77	1-20	School education level and health status (physical, social and psychological) with a 6-year follow-up	Interaction between school education, physical health and cognitive performance. LSE highlights the decline of physical performance, due to age
12. Gitlin *et al.*[40] (2008)	319	≥70	G1: ≤8 G2: 9-11 G3: ≥12	Performance in daily living activities, after explanations on how to use tools, keep energy, safety, recovering from falls	Benefit vary according to school education level. Individuals with LSE benefit more from intervention, probably because they tend to have less Access to information

Continue...

Chart 1. Continuation

Authors (year)	Number of subjects	Age (years)	School education (years)	Tasks	Results
13. Tun e Lachman[29] (2008)	3616	32–85	G1: <16 G2: ≥16	Tasks of verbal reaction time alternating between sequences and inhibitory control	Individuals with LSE present worse performance and executive efficiency. Adults with superior education present performance similar to younger individuals with 10 years less school education
14. Brucki e Nitrini[11] (2008)	55 adults 27 elderly	G1:50–64 G2: ≥65	G1: IL (have never gone to school) G2: IL (have already gone to school) G3: 1–4	Task of canceling figures (number of correctly canceled figures and visual search strategy)	L individuals present higher performance that IL ones, among IL, the ones who had already gone to school presented better performance
15. Neves[20] (2008)	42	≥60	G1: 1–7 G2: >7	Opposing fingers sequence (verification of learning and of transference of the skill for the other sequence, not trained)	The group with LSE does not transfer learning for the not trained sequence. The group with LSE performs a lower number of sequences per minute
16. Bramão *et al.*[21] (2007)	G1: 21 G2: 20	≥60	G1: IL G2: L	Switching a target presented on a screen, with the right or left index finger	IL individuals are slower to detect and switch targets, specially to the left
17. Camargos *et al.*[44] (2007)	2143	≥60	G1: ≤4 G2: ≥5	Getting dressed, taking a shower, using the toilet, laying down and getting up from bed, walking inside the house	Individuals with LSE present more functional difficulties and higher risk of functional difficulties during the last years of life
18. Jagger *et al.*[43] (2007)	13004	≥65	G1: 0–9 G2: 10–11 G3: ≥12	Capacity of mobility (going up and down stairs) and performing daily living activities (sitting down and getting up from a chair, putting shoes and socks on, preparing meals, walking outside the house, taking a shower)	Individuals with ISE present greater functional difficulties
19. Van der Elst *et al.*[25] (2006)	1856	24–81	G1: 1–7 G2: 8 G3: ≥9	Stroop test	Performance worsens with age and this worsening is more pronounced among individuals with LSE
20. Hester *et al.*[36] (2005)	363	60–89	G1: ≤11 G2: >11	Trail making test A (connecting numbers tracing a paper sheet) and B (connecting alternate letters and numbers)	Elderly individuals with LSE present more difficulty, specially in part B
21. Dansilio e Charamelo[15] (2005)	15 IL 15 A	≥60	G1: 0 G2: 6–7	Reproduce figures with drawings on a paper	Worst performance by individuals with LSE
22. Nitrini *et al.*[16] (2005)	745	≥65	G1: 0 G2: 1–3 G3: 4–7 G4: ≥8	Fist-edge-palm test (sequential manual movements)	Worst performance by individuals with LSE
23. Cavalcante[22] (2004)	60	≥60	1–10	Recognizing and performing several gestures	Individuals with LSE make more mistakes
24. Barnes *et al.*[38] (2004)	664	≥65	≤15 >15	Trail making test, Stroop test, mini exam of mental state (cognition/ executive function); North America Adult Reading Test (literacy)	Correlation between the performance in tests which assessed literacy and in cognitive and executive function tests
25. Nitrini *et al.*[9] (2004)	51	≥60	G1: IL G2: L	Clock test	LSE individuals make more mistakes
26. Tombaugh[37] (2004)	911	18–89	G1: ≤11 G2:> 11	Trail making test	Worst performance by LSE individuals
27. Homann *et al.*[33] (2003)	187 healthy adults 200 with Parkinson's disease	30–85	G1: 8 G2: ≥9	Pushing alternate buttons on a computer keyboard as fast as possible, though without compromising accuracy	Elderly individuals with LSE presented slower speed in performing the movement of pushing buttons
28. Castro-Caldas *et al.*[2] (1998)	12	≥50	G1: L G2: IL	Task of words and pseudo words repetition and tomography with positron emission	In the repetition of words, the groups presented similar performance and brain activation patterns. IL have greater difficulty with pseudo words and they do not activate the same brain structures

G1: studied group 1; G2: studied group 2; G3: studied group 3; IL: illiterate; L: literate; LSE: Low school education

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