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# Analysis of postural balance in older adult practitioners and non-practitioners of Pilates

## Análise do equilíbrio postural em idosos praticantes e não praticantes de Pilates

Liliam Graziely Rodrigues da Cruz[1], Willian Bernard de Paula Effgen[1], Daniela Branco Liposcki[1], Mabel Gonçalves Almeida[1], Janine Carvalho Valentino Camargos[1], Natalia Madalena Rinaldi[1].

1. Federal University of Espírito Santo, Vitória, ES, Brazil.

**ABSTRACT**

**Background:** The aging process causes physiological changes on psychic and functional aspects. In this sense, there is a decline in functional capacities such as strength, balance, proprioception and flexibility, caused by neuromuscular impairment. **Aim:** This study aimed to analyze the effect of Pilates practice on postural balance in older adults. **Methods:** The study included 34 elderly (25 female and 9 male) distributed into two groups: Practitioners and Control (non-Pilates practitioners). At first, a socio-demographic questionnaire was performed to characterize the sample. Following, the variables analyzed were the items and scores obtained in the BESTest sections, and the scores of the Mini-Mental and Baecke questionnaires (adapted version for older adults). **Results:** No statistical differences were found between Pilates and Non-Pilates groups for the following items: age, falls, height, body mass, BMI, Mini-Mental and Baecke. However, there was a statistical difference for BESTest, the Pilates group presented a higher overall score when compared to control group, representing a superior difference of 14.68%. **Conclusion:** We concluded that Pilates practice seems to promote benefits in dynamic balance in the elderly and can be an important tool to minimize the risk of falls.

**Key-words:** Balance, Aging, Older adults, Pilates.

**RESUMO**

**Introdução:** O processo de envelhecimento ocasiona uma série de mudanças fisiológicas, as quais estão associadas aos aspectos psíquicos e funcionais do corpo humano. Neste sentido, há o declínio das capacidades funcionais como força, equilíbrio, propriocepção e flexibilidade, ocasionado pelo comprometimento neuromuscular. **Objetivo:** Este estudo teve como objetivo analisar o efeito da prática de Pilates no equilíbrio postural em idosos. **Métodos:** Participaram do estudo 34 idosos, dentre os quais 25 do sexo feminino e 9 do sexo masculino, os quais foram distribuídos em dois grupos: Praticantes de Pilates e Não Praticantes de Pilates. As variáveis relacionadas foram os itens e scores obtidos nas seções do BESTest, bem como o score do Mini-Mental e Baecke. **Resultados:** Não foram encontradas diferenças estatísticas entre os grupos Praticantes de Pilates e Não Praticantes de Pilates para os itens: idade (t1,32 = 0,416, p = 0,680), quedas (t1,32 = 0,000, p = 1,000), estatura (t1,32 = 0,542, p = 0,592), massa corporal (t1,32 = 0,380, p = 0,705), IMC (t1,32 = 1,143, p = 0,262), MiniMental (t1,32 = -1,791, p= 0,083) e Baecke (t1,32 = -0,92, p = 0,928). Entretanto, o teste T apresentou diferença estatística para o BESTest (t1,32t32 = -2,750, p= 0,010), tendo o grupo Praticante de Pilates uma pontuação geral maior (Praticante de Pilates = 91 (7,15) / Não Praticante de Pilates = 77,64 (19,52). **Conclusão:** Diante dos resultados, conclui-se que a prática de Pilates promoveu benefícios no equilíbrio dinâmico nos idosos e uma importante ferramenta para prevenção de quedas.

**Palavras-chave:** Equilíbrio, Envelhecimento, Idosos, Pilates.

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Correspondence: Natalia Madalena Rinaldi, Centro de Educação Física e Desportos, Av. Fernando Ferrari, 514, 29075-910 Vitória ES, Brazil, E-mail: natalia.rinaldi@ufes.br

## Introduction

Aging is a fact of worldwide relevance, which results from factors such as the drop in fertility rates and an increase in life expectancy [1]. Nowadays, there are around 962 million individuals over the age of 60 in the world, corresponding to 13% of the world's population [2]. In Brazil, there was an increase of 4.8 million older adults people from 2012 to 2017, surpassing 30.2 million older adults people in 2017 [3]. The aging process causes a series of physiological changes, which are associated with the psychic and functional aspects of the human body. The psychic aspects involve sensory stimuli and reactions (voluntary, involuntary and reflexes), and the functional aspects involve the cognitive functions.

In this context, the regular practice of physical activities causes several benefits to older individuals, among them increased aerobic capacity, improved muscle strength and flexibility, improved balance and coordination. In the perspective of the aspects involved in the aging process, the human balance has been investigated in several studies in the literature [4]. The balance depends on three perceptive systems: vestibular, proprioceptive and visual [5]. In addition to relying on the integrity of these three systems, balance is also dependent on sensory integration in the central nervous system, which involves spatial visual perception, muscle tone adaptation to abrupt changes, joint strength and flexibility. Thus, the sensory organization is important for the maintenance of balance and sensory information (visual, vestibular and proprioceptive) is integrated by the central nervous system [5]. In function of aging process, there is deficiency in the adjustments of the equilibrium system, consequently, there is a decrease in the speed of information transmission and in the processing of responses, generating situations of instability and increasing predisposition to falls [6].

Moreover, given the specificities caused by the aging process, several health promotion strategy has been widely used with the older adults public, among them is the Pilates method, developed by Joseph H. Pilates, which consists of a series of exercises that promote core stability, strength, flexibility, attention to muscular control, posture and breathing, leading to positive responses in body composition, functional capacity, and for balance of the older adults [7]. The Pilates method has effects on the risk of falling due to the reduction of the intrinsic factors (sarcopenia, decreased balance, reduction of fast mechanical response and synergy) and extrinsic factors (fear of falling, depression), which positively reflects on the risk of falls, since there is a decrease in loss of muscle mass and consequent gain, improvement of balance and mechanical responses. For example, Bird and Fell [8] investigated the effect of the Pilates method on the risk of falls of 30 older subjects for 5 weeks and observed that there was improvement in balance and strength of the lower limbs, as well as a decreased risk of falls. This study also evaluated older adults patients after 12 months of initial intervention, and verified that the older adults still had considerable values in relation to balance, regardless of whether or not they continued the practice of Pilates. The older adults who continued with the exercises obtained strength gains. Thus, the regular participation of older adults in exercise programs such as Pilates prevents the development and progression of chronic diseases, prevents falls, promoting a consequent increase in quality and life expectancy [7]. Pinheiro *et al.* [9] investigated the influence of Pilates method on the strength and conductivity of the electrical stimulation of the lumbar paravertebral muscles, as well as the contraction of the transverse abdomen muscle in 13 older women before and after exercise. These authors found improvement in strength and electrical conductivity of the lumbar

stabilizing muscles of the older adults was observed, therefore, Pilates training positively influenced this musculature.

However, the effect of Pilates practice on postural balance in the older adults has not been fully elucidated. Therefore, this analysis can investigate in which component of balance the practice of Pilates may improve. To verify this possibility of improvement, the BESTest is a clinical balance assessment tool that investigate different balance systems (biomechanical constraints, transitions/anticipatory, reactive, sensory orientation and stability in gait) and it is possible to identify the type of equilibrium problem to direct specific treatments to older adults. So, the aim of this study was to investigate the Pilates method on balance in the older adults and to show specifically the components of balance that could be affected, or not, by Pilates training, through the BESTest. Furthermore, we expected that older adults involved in Pilates training will present a better performance in some subitens of BESTest such as sitting on floor and stand up, sitting verticality and lateral lean, functional reach - forward, functional reach - lateral, compensatory stepping correction – lateral, change in gait speed, walk with head turns – horizontal, walk with pivot turns, timed "get up & go" and timed "get up & go" with dual task than older adults that is not involved in Pilates training.

## Methods

### *Participants*

Thirty-four older adults (25 females and 9 males) were distributed into 2 groups: Pilates (experimental group): 17 older adults who practiced Pilates for at least 3 months (12 women and 5 men), Non Pilates (control group): 17 older adults people who did not practice any physical activity for at least 3 months (13 women and 4 men), or who had some level of daily physical activity. The participation in the study was voluntary and was applied only for those who signed the Consent Form. The invitation of the participants was with the supervisor of the studios of Pilates (who applied the training program). It was selected 27 studios and gyms that offer Pilates training, but 15 were included (3 were closed and 9 decline to participated). The inclusion criterion to the older adults was: to practice the activities proposed by the Pilates methodology in the two categories: mat Pilates, include exercises on the ground and with no specific equipment; and the Pilates apparatus, where exercises were performed in some equipment developed by Pilates (reformer, cadillac, wall unit, combo chair) [10]. The participants must have a weekly frequency of two days, in one hour session for at least three months. The exclusion criteria were absence of neurological, vestibular and musculoskeletal diseases that could compromise the performance of motor tasks, the use of orthoses or prostheses and medications with a postural balance. This study was approved by the Ethics Committee of the Federal University of Espirito Santo, with number 2.455.865, on December 22, 2017.

### *Experimental procedures*

Initially, an anamnesis questionnaire was applied to verify the inclusion and exclusion criteria, as well as to investigate the clinical condition and the number of falls of the older adults. In addition, the questionnaire of the Mini Mental State Exam [11] was applied to evaluate the cognitive functions of the older adults. The Baecke questionnaire [12] was used to verify the level of physical activity (daily activities, sports and leisure) of each group. For clinical evaluation of the static and dynamic balance, the BESTest scale was used with 36 items [13]. This protocol consists of the

analysis of six essential patterns for maintaining posture and balance, and are:

1) Biomechanical Restrictions: analyzes the base of support, center of mass alignment, ankle strength and amplitude, hip / trunk lateral force, sit on the floor and lift.
2) Stability limits: sitting vertical and lateral inclination, functional range forward and lateral functional reach.
3) Transitions - Anticipatory posture adjustments: sitting upright, standing on tiptoes, standing on one leg, tapping step alternately, standing up arm.
4) Reactive postural responses: response in place (forward), response in place (backward), correction with compensatory step (forward), correction with compensatory step (backward) and correction with compensatory step (lateral).
5) Sensory orientation: sensory integration for balance and inclination (eyes closed).
6) Stability in gait: gait (flat surface), change in gait speed, walking with head-turns (horizontal), walking and spinning on the shaft, passing over obstacles, timed Get Up & Go and Get Up & Go "timed with dual task".

### *Dependent variable*

The dependent variables used in this study were the obtained scores in each questionnaire (Baecke and Mini Mental) and in The Balance Evaluation Systems Test (BESTest).

### *Statistical analysis*

To verify the normality and homogeneity of the data, the Shapiro Wilk test and the Levene test were used, respectively. The data presented normal distribution. Thus, the Student's t-Test with independent measures (group: Pilates vs. Non Pilates) was performed to verify possible differences between the groups for the following variables: scores of clinical evaluations (height / body mass, Baecke, Mini-Mental, BESTest and BESTest items). For all analysis, the level of significance was set at $p \leq 0.05$.

## Results

We did not find difference between Pilates and Non Pilates for age ($t_{1,32} = 0.42$, $p = 0.68$), history of falls ($t_{1,32} = 0.00$, $p = 1,00$), height ($t_{1,32} = 0.54$, $p = 0.59$), body mass ($t_{1,32} = 0.38$, $p = 0.70$), IMC ($t_{1,32} = 1.14$, $p = 0,26$), Mini Mental ($t_{1,32} = -1.79$, $p = 0.08$) and Baecke ($t_{1,32} = -0.92$, $p = 0.93$) (Table I). However, we found difference between Pilates and Non-Pilates groups for BESTest ($t_{1,32} = -2.75$, $p = 0.01$). In relation to the total score of BESTest, the Pilates Group presented a greater performance than the Non-Pilates group (Pilates = 91 (±7.15) pts | Non-Pilates = 77.64 (±19.52) pts).

**Table I - Mean and standard deviation in parentheses of age, body mass and height, clinical tests (Baecke, Mini-Mental, BESTest) for Pilates and non-Pilates groups and p-value ($p \leq 0.05$).**

| | Pilates (n=17) | Non pilates (n=17) | p Value |
|---|---|---|---|
| Gender | 12 F / 5 M | 13 F / 4 M | - |
| Age | 68.05 (16.77) | 69.88 (6.66) | 0.68 |
| Body mass (kg) | 72.88 (13.14) | 74.58 (12.85) | 0.705 |
| Stature (m) | 1.62 (0.09) | 1.61 (0.083) | 0.592 |
| IMC (kg/m²) | 27.28 (2.69) | 28.65 (4.14) | 0.262 |
| Falls (≥ 1 last year) | 0.41 (1.22) | 0.41 (0.61) | 1 |

F: Female sex; M: Male sex.

In relation to the items of the BESTest, we found difference for the following balance domains: Biomechanical constraints (sit to stand, $t_{1,32} = -2,46$, $p = 0.019$); Stability limits (sitting vertical and lateral lean, $t_{1,32} = -4.91$, $p = 0.00$, functional reach

Rev Bras Fisiol Exerc 2020;19(3):209-217

forward, t1,32 = -2,38, p = 0.023 and functional reach lateral, t1,32 = -2.25, p = 0.031); Reactive postural responses (compensatory stepping correction - lateral, t1,32 = -2,34, p = 0.026) and, finally, Stability in gait (change in gait speed t1,32 = -2,47, p = 0.019); walking with head turns - horizontal, t1,32 = -2.068, p = 0.047, walking with pivot turns, t1,32 = -2,805, p = 0.008, timed "Get up & Go", t1,32 = -2.949, p = 0.006 and timed "Get up & Go" with dual task, t1,32 = -2.733, p = 0.01) (Figure 1).

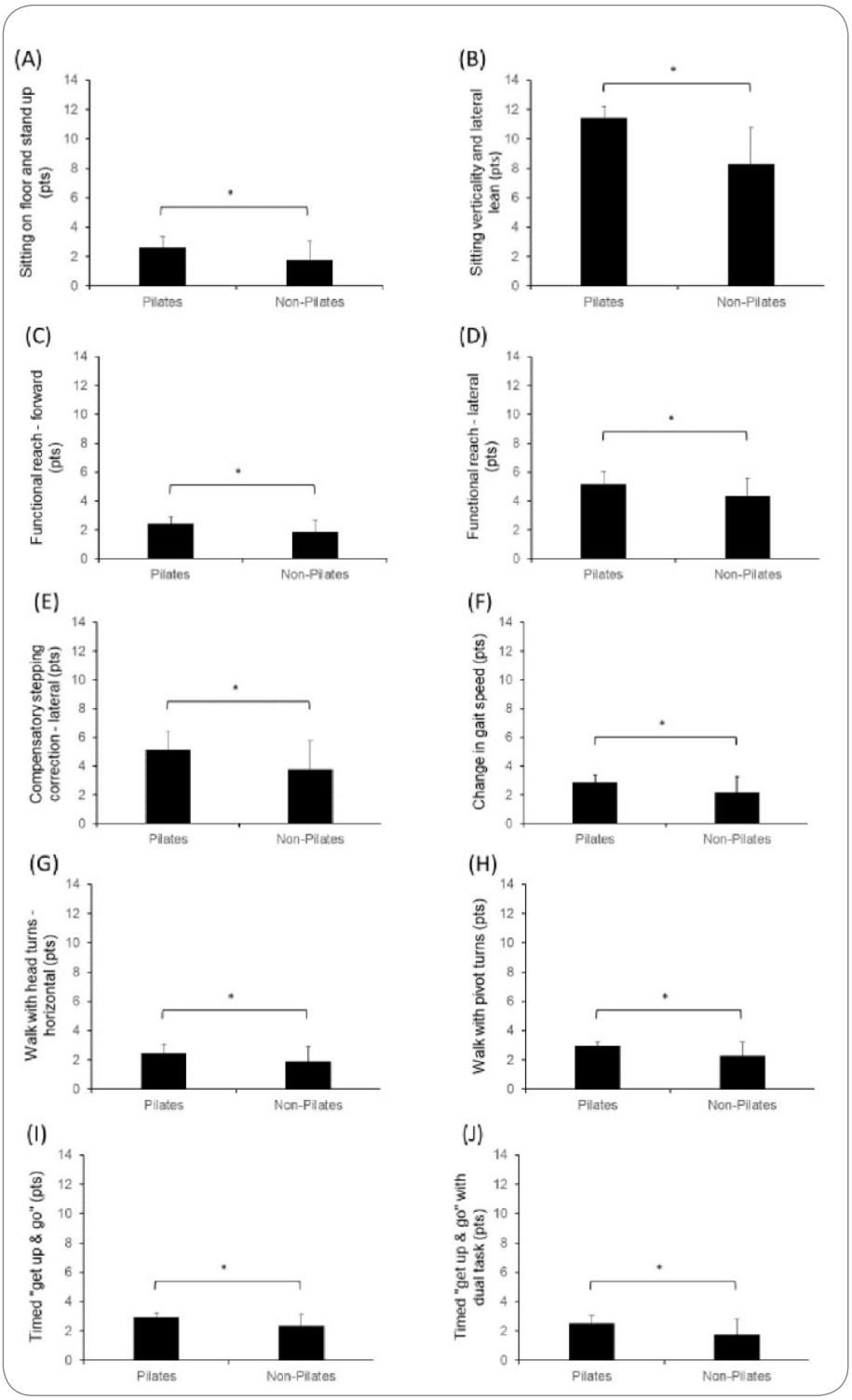


**Figure 1 - Mean and standard deviation of items A) sit and stand up, B) sitting vertical and lateral slope, C) functional range forward, D) lateral functional reach, E) correction with lateral compensatory step, F) change in speed, G) Walk with head turns horizontal, H) Walk with pivot tunrs I) get up & go timed, J) get up & go timed with dual task, for the older adults groups Pilates and Non-Pilates (*p ≤ 0.05).**

## Discussion

The aim of this study was to compare the effect of the Pilates Method on the components of the older adults balance, comparing the balance through the subitems of the BESTest scale [13]. This protocol consists of the analysis of six essential patterns for maintaining posture and balance (Biomechanical Restrictions, Stability Limits, Transitions - Anticipatory Postural Adjustments, Reactive Postural Responses, Sensory Orientation and Stability in Gait) [13]. In relation to the clinical variables, such as, cognitive aspects, which were evaluated by Mini-Mental test [11], and anthropometric variables (BMI, body mass, stature), no statistical differences was found between the groups (Pilates x Non-Pilates) that indicates that the cognitive level and the anthropometric characteristics was paired.

For the 27 BESTest sub-items, only 10 sub-items showed statistical difference between groups, and were: sit on the floor and stand up; seated verticality and lateral inclination; functional forward range; lateral functional reach; correction with compensatory-lateral step; change in walking speed; walking with horizontal-head turns; walking and spinning on the shaft; get up & go timed and get up & go timed with dual task. Thus, improvement of these sub-items of the BESTest demonstrates that, training in the Pilates method may work on strengthening lower limbs [14]. Flores *et al.* [14] investigated the effects of 30 sessions of Pilates mat on the flexibility of the posterior chain, flexibility of the lower and upper limbs, strength of the lower limbs and the quality of life in older women. 45 older women, distributed into an experimental group and a control group, participated in the study. There was significant improvement in the experimental group of posterior chain flexibility, flexibility and strength of the lower limbs, and quality of life. Moreover, older adults who practice Pilates presented a higher overall score at BESTest than non-practicing older adults (91 (7.15) and 77.64 (19.52), respectively), confirming the hypothesis presented by this study. These results show that Pilates method presents a positive effect on the components of balance systems, as we showed in this study by the BESTest scale. The Pilates method uses low-speed muscle work to promote body control through the exercises performed. The principles used in this methodology (concentration, control, accuracy, movement fluidity, breathing and center of force contraction) combined with exercise result in the main benefits of the practice (could increase flexibility and muscle strength) [15]. Thus, the principles of the Pilates method can be analyzed together with the components of postural balance (biomechanical restrictions, stability / verticality limits, anticipatory postural adjustments, postural responses, sensory orientation and gait stability), which were analyzed through the six balance systems in BESTest. In this context, BESTest was the instrument that allowed the complete analysis of the balance components present in the Pilates method practice, allowing us, for example, to observe that the Pilates method training may strengthened the lower limbs, improving the squat and lift performance, seen in the item sit on the floor and stand up. It also acted in stabilizing the core by working the abdomen (internal oblique, external, transverse), gluteus, biceps femoris, spine erectors, as seen in the sitting upright and lateral inclination, forward functional range and lateral functional range and, finally, Pilates method can increase the gait stabilization and reactive actions, seen in the items compensation with lateral compensatory step, change in gait speed, walking with horizontal head turns, walking and turning on the axis, get up & go timed and get up & go timed with dual task.

Another item analyzed was the level of daily physical activity (Baecke), which consists of a questionnaire adapted from Baecke, Burema and Frijters [12] for older

adults. This questionnaire addresses 10 questions about domestic activities as well as questions about activities performed during leisure or sports. Baecke test did not detected a difference between the groups, which indicates that the older adults had similar levels of physical activity when starting the intervention with the Pilates method. Although there was no statistical difference on Baecke test, the score of the Pilates group was higher than non-practicing group only on BESTest, so it is important to mention that the Pilates practice was a differential for the older adults that were involved in Pilates activity.

In function of the training protocol and the specificities of the aging process (sarcopenia, loss of flexibility, decreased cognitive functions, loss of muscle strength and impaired balance), the benefits of Pilates practice to the older adults are remarkable. Therefore, the Pilates method influences postural control, because it is composed of a series of exercises that promote core stability, strength, flexibility, attention to muscular control, posture and respiration, requiring adaptations and responses of the perceptive systems (vestibular, proprioceptive and visual), and muscular, causing positive responses in body composition, functional capacity, and in the balance of the older adults [16]. Moreover, the flexibility could be improved, because exercises were performed with greater joint amplitude, enabling the improvement of the force in different joint angles that changes the movement control and can prevent injuries, consequently promoting the improvement of the individual's functional capacity [14]. Finally, Barker *et al.* [17] investigated the effect of Pilates on balance and falls in older adults, and whether programs tested in prior studies attend to recommendations for physical exercise to prevent falls. They suggested that Pilates method can improve balance and it is an important risk factor for falls in older adults. In this systematic review, authors found some studies that showed an improvement in balance after Pilates sessions, however, most of studies in this review only evaluated body balance using TUG, force plate and POMA tests. In this present study, we used a balance test that can evaluate different balance systems (biomechanical constraints, transitions/anticipatory, reactive, sensory orientation and stability in gait) and it is extremely important that this scale can help to detect different types of equilibrium problems to prevent falls and to give a specific rehabilitation to older adults.

One limitation found in this work was the non-control of Pilates practice time. Some older adults practiced Pilates a few years ago, while other older adults people practiced only a few months ago. This chronic practice time of some of the participants may have overestimated the values of the BESTest total score. Therefore, it is suggested that new studies work with a greater control of the participants practice time. Although, it is suggested that a group of non-practitioners of Pilates be trained by 12 weeks, with a pre and pos-training evaluation by BESTest, to really assure the benefits presents from the Pilates method.

## Conclusion

It is possible that regular practice of the Pilates method promotes muscular strength gain, flexibility, hypertrophy, body control and also improves other components of postural balance (vestibular, visual and proprioceptive system; biomechanical constraints, stability / verticality limits, transitions / anticipatory , reactive, sensory orientation and gait stability). Moreover, it is concluded that the practice of Pilates presented benefits in the dynamic balance of the older adults, can reduce the risk of falls and, consequently, the improvement of the quality of life.

**Potential conflict of interest**
No conflicts of interest with potential potential for this article have been reported.

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**Academic link**
There is no link between this study and graduate programs.

**Authors' contributions**
Conception and design of the research: Liposcki DB, Almeida MG, Rinaldi NM. Data collection: Cruz LGR, Effgen WBP. Analysis and interpretation of data: Cruz LGR, Effgen WBP, Rinaldi NM. Obtaining financing: None. Writing of the manuscript: Cruz LGR, Effgen WBP, Liposcki DB, Almeida MG, Camargos JCV, Rinaldi NM. Critical review of the manuscript for intellectually important content: Cruz LGR, Effgen WBP, Camargos JCV, Rinaldi NM.

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