



## Feasibility of shadow Moiré Technique to identify postural disorders in schoolchildren

### *Exequibilidade da Técnica de Moiré de sombra na identificação de desvios posturais em escolares*

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#### ABSTRACT

This study aimed to examine the feasibility of the Shadow Moiré Technique (SMT) in carrying out periodic school screenings and to identify the prevalence of postural disorders in students from a public school in Rio de Janeiro. The sample was comprised of 304 students. The SMT exam was based on the difference in the number of fringes in the dorsal and scapulothoracic regions. The feasibility of the SMT was identified based on predetermined parameters. Two hundred and twenty-five subjects were identified with fringe difference in the dorsal region and 224 were identified with fringe difference in the scapulothoracic region. Regarding feasibility, the sample was examined over the period of 7 days. There were no difficulties in obtaining the materials, in the use of the technique or in the processing of the images. SMT was considered feasible to screen the population and it allows for large-scale periodic examination. The SMT can be a strategy for implementing public health programs at school aiming at improving the quality of life.

**Keywords:** Adolescent. Children. Feasibility studies. Moire Topography.

#### RESUMO

O objetivo deste estudo foi examinar a exequibilidade do uso da Técnica de Moiré de Sombra (TMS) em triagens periódicas no ambiente escolar e estabelecer o estado da prevalência de desvios posturais em uma escola pública do município do Rio de Janeiro. A amostra se compôs por 304 alunos. O exame da TMS baseou-se na diferença do número de franjas nas regiões dorsal e cintura escapular. A exequibilidade foi identificada considerando-se parâmetros preestabelecidos. Identificaram-se 225 sujeitos com diferença de franjas na região dorsal, e 224 com diferença de franjas na cintura escapular. Quanto à exequibilidade, a amostra foi examinada em sete dias e não houve dificuldades na execução da técnica, no processamento das imagens e nos materiais requeridos. Considerou-se a TMS exequível para triagens populacionais, permitindo exames periódicos em larga escala. A TMS pode ser uma estratégia na implementação de programas de saúde pública na escola, objetivando a melhora da qualidade de vida.

**Palavras-chave:** Adolescentes. Crianças. Estudos de viabilidade. Topografia de Moiré.

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## INTRODUCTION

Postural deviations are common findings in childhood and adolescence<sup>1,2</sup>. It is typical that in these periods of life, individuals show accelerated growth, characterized by continuous adjustments in the dimensions of body segments<sup>3</sup>. Different variables determine the progression of the aforementioned changes, including those related to heredity, physical and environmental conditions, habits of daily living, socioeconomic status and others<sup>4</sup>.

As a result of this scenario, it is recommended that children and adolescents undergo periodic screening<sup>5</sup>, since evidence indicates that the early detection of postural changes is the first step to establish and apply prevention and/or treatment strategies<sup>1,2,4,5</sup>. Such procedures contribute to the purpose of reducing the likelihood of future aggravations<sup>6</sup>. It seems that the adoption of these actions in youth results in a better state of health of the spine in adulthood and, consequently, in the quality of life of people<sup>7</sup>.

In Brazil, the articulation of initiatives aimed at intersectoral public health promotion policies is encouraged, with an emphasis on integration between the health and education sectors<sup>8</sup>. Under this guidance, the National Health and Education Program<sup>9</sup> was instituted, aiming, notably, to meet and expand specific health actions for students in the public school system<sup>8</sup>. This is a proposal especially suited to the implementation of periodic screening actions in the medium and long term, as well as the implementation of preventive measures<sup>10,11</sup>, since an expressive number of students will remain in the school for a long period, enabling a longitudinal follow-up, as well as referral to specialized health services<sup>12</sup>, when applicable.

Among the possible screening strategies for identifying postural disorders, there is the Shadow Moiré Technique (SMT), which, being a scientifically authenticated procedure<sup>13</sup>, non-invasive<sup>14</sup>, rapidly applied, with low cost<sup>15</sup>, is suitable to be used in screening actions for schoolchildren<sup>15,16,17</sup>. It enables the identification and recording postural deviations in the spine by reconstructing the spatial shape of the

anatomical structure, based on the examination of the topographic configuration of contour lines produced on the body back<sup>13,14,15,16,17,18,19</sup>.

As can be seen, there are facts indicating that: a) the periodic examination of the postural status of children and adolescents is an important public health action; b) the school seems to be an adequate environment for the implementation of this type of action; and c) there is a non-invasive and low-cost technology that allows obtaining the necessary data for postural examination. However, it is not possible to affirm that the implementation of a regular process of such screening is feasible in practice, since no reports of studies carried out with the purpose of identifying, through SMT, postural deviations in school children and adolescents in the municipality of Rio de Janeiro were found in the reviewed literature

In view of the above, the present study was developed with the main objective of examining the feasibility of using the Shadow Moiré Technique in conducting periodic screening in the school environment and, together with this, establishing the prevalence of postural deviations in a school of the municipality of Rio de Janeiro.

## METHODOLOGY

The population where the study was conducted consisted of 900 subjects, students from a public school in the city of Rio de Janeiro, located in an area of extreme social vulnerability. All were invited to take part in the research and received the Informed Consent Form (ICF) for reading and signing by those responsible, who should agree with the participation of their dependents. The individuals who returned with the signed informed consent form were included in the study, resulting in a sample, established by convenience, of 304 people (169 females and 135 males, with an average age of 11.5 years  $\pm$  2.6 years, 44.9  $\pm$  15.3 kg, 150.3  $\pm$  14.6 cm); a 95% confidence level was adopted, resulting in a margin of error of 4.58%.

The age range of the sample is adequate for the purpose of the present investigation, in view of the existing evidence that it is common to find postur-

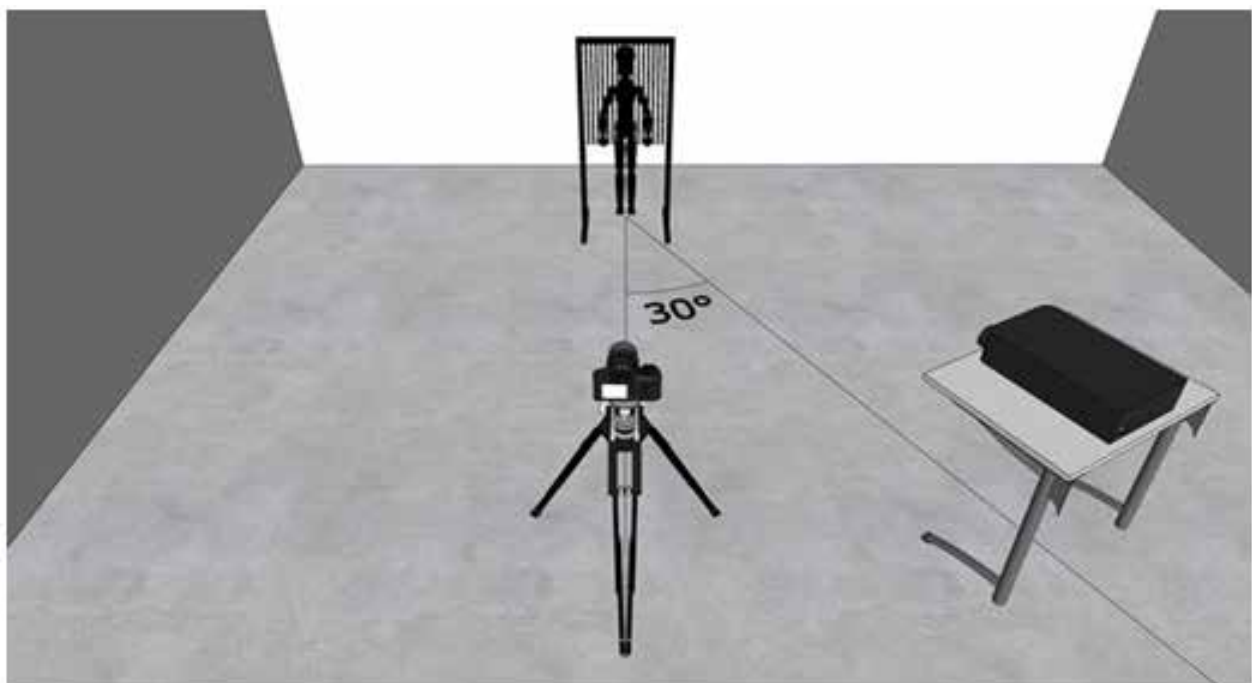
al changes in individuals of this age group<sup>1,2,4,5,6,7</sup>. The project was approved by the Research Ethics Committee of the University Hospital Pedro Ernesto, from the State University of Rio de Janeiro (opinion 3.705.958).

Two undergraduate Physical Education students underwent training in order to be able to apply the SMT protocol<sup>13,18,19</sup>, whose purpose is to identify postural deviations of the spine and scapular girdle. They fulfilled the basic requirement of having already taken the curricular subjects of Cineanthropometry, Biomechanics and Therapeutic Physical Education, since they convey the basic knowledge necessary to use the technique and to interpret the results produced.

Anthropometric data of mass and height were measured according to the procedures established by the International Society for the Advancement of Kinanthropometry (ISAK). The devices used to collect TMS data were: a 2 mm thick, 50 cm wide and 60 cm high, gridded acrylic plate; a common slide projector (IEC, model LH-150) as a light source; and a Fujifilm Finepix J20 photo camera with 10 megapixels.

To produce the Moiré effect, the acrylic plate was gridded, using silk screen printing, with vertical lines 1 mm thick positioned 1 mm apart. In order to obtain a properly darkened collection environment for producing the Moiré Shadow effect<sup>13,18,19</sup>, a tent, closed on the sides, with 9 m<sup>2</sup>, was used as a booth. As the test protocol requires that the test subject has a bare back at the time of registration, to avoid embarrassment and body exposure during data collection, the volunteers were instructed to wear an apron that covered the entire anterior region of the trunk, leaving only the dorsal region to be recorded exposed.

After, the person was positioned in a fundamental position with the back facing the screen, as seen in Figure 1. Once this was done, the light source was activated, producing the Moiré effect on the individual's back, and the photographic record was made.



**Figure 1.** Organization of the space for examining the Shadow Moiré Technique (SMT).

Source: prepared by the authors

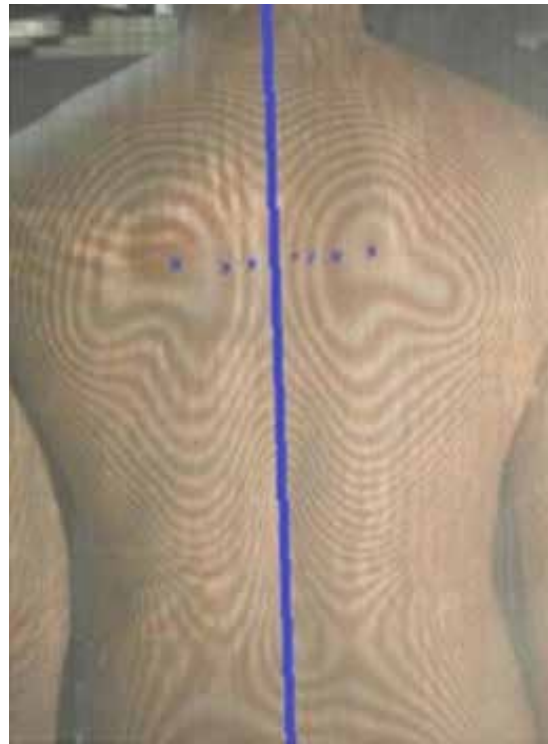
For each subject examined, three photographic records were made, and the one with the greatest clarity was used for the examination of SMT. At the same time that an analyst collected the image of a subject, the other surveyed the anthropometric data of mass and height of the next participant. Anthropometric information was used to characterize the sample's volunteers and is described in the presentation at the beginning of this section. These procedures were supervised by the project's research coordinator and two school teachers.

After obtaining data, the two operators went through a second phase of training in SMT to acquire the knowledge of the analysis and processing the recorded images. The SMT exam was performed using scientifically authenticated protocols<sup>18,19</sup>, based on counting the number of fringes in two regions of the body. According to Willner<sup>19</sup>, the difference in the number of fringes on the right and left sides in the dorsal region of the spine is considered an indicator of suspected scoliosis in this region, as shown in Figure 2.



**Figure 2.** Individual with fringe difference in the dorsal region.  
Source: prepared by the authors.

According to Warner et al.<sup>18</sup>, the difference in the number of fringes on one side and the other identified in the scapular girdle region is an indicator of postural deviation related to changes in the position of the shoulder girdle or in the shoulder joints, as illustrated in Figure 3.



**Figure 3.** Individual with fringe difference in the scapular girdle region.

Source: prepared by the authors.

The Paint software (version 16067), available on the Windows platform, was used to observe the images.

The feasibility of the Shadow Moiré Technique was examined based on data obtained during the entire data collection and analysis process, and the following parameters were adopted: (1) SMT exam time; (2) space required to perform the procedures; (3) degree of ease of application of the technique; (4) degree of ease in data processing; and (5) access to the material required for the exam.

## RESULTS

In the sample examined, 79 individuals (26%) showed no difference in fringes in the dorsal region,

whereas 225 (74%) showed an evident difference. As for the difference in fringes at the shoulder girdle, it was observed in 224 students (73.7%) and not identified in 80 (26.3%). There was 100% agreement between the results presented by the two analysts.

Regarding feasibility, it was found that the Shadow Moiré Technique is feasible for periodic screenings in the school environment, according to the parameters described in Chart 1.

**Chart 1.** Description of feasibility parameters of the Shadow Moiré Technique

Parameter	Result	Description
Time of the SMT exam	7 to 10 minutes per individual	The 304 sample participants were collected in a total interval of seven days.
Space required for procedures	Minimum area of 30 m <sup>2</sup>	The entire collection was made in a classroom of the school, with 72 m <sup>2</sup> ; however, for the specific registration of SMT images, an area of 30 m <sup>2</sup> was sufficient, equivalent to the minimum area for the execution of all procedures.
Degree of ease of application of the technique	High degree of ease	It was found to be sufficient the participation of two evaluators, who were trained for ten hours in the procedures of the postural examination technique.
Degree of ease in data processing	High degree of ease	The analysts found no difficulties in working with the images, carrying out the analysis of the individuals (n = 304) in seven days, after training for 20 hours distributed over four days. It was also found that the use of SMT does not require the use of software or complex programming language for the interpretation of images.
Access to the material required for the exam	Accessible	The material necessary for implementation of the technique is low cost and currently used in the school environment, with the exception of the Moiré plate, which needs to be made. However, it is also low-cost, easy to build and is valid for an indefinite period of time, and can be used indefinitely in subsequent collections, provided it is properly packaged.

Source: prepared by the authors.

## DISCUSSION

The present study was developed with the main objective of examining the feasibility of using the Shadow Moiré Technique for periodic screenings in the school environment, and together with this, identify the prevalence of postural deviations in a public school in the municipality of Rio de Janeiro.

Such purposes allowed to verify if it is possible to install, in a public school in that city, a perennial screening program, aiming to produce information about postural deviations in children and adolescents. Such a possibility is part of a broader approach with a view to developing a health surveillance program for school children and adolescents. In this first venture into the topic, we chose to focus the examination on the deviations present in the trunk area, since this region is commonly susceptible to the emergence of

severe postural problems<sup>5</sup> that tend to worsen with advancing age, with a significant magnitude of prevalence in the adult population<sup>2,4,13</sup>.

For the examination of posture, we opted for three-dimensional topography - more specifically the Shadow Moiré Technique (SMT). The choice was based on the fact that it has low cost, suitable to be used in the examination of large contingents of patients, of simple application and production of results. However, these characteristics should not be seen as indicators of metrological inefficiency.

We accept as true the premise that the feasibility of a technology or examination strategy should not be based merely on the ease of its construction and the potential to produce data. Nevertheless, the use of SMT to examine the postural status of people goes beyond this scope, since this technique, despite being characterized by the simplicity of the applica-

tion protocol and the hardware used, has its genesis based on a clear, grounded and consensual conceptual basis. In this sense, it fulfills, therefore, the necessary requirements for the production of quality indicators, especially with regard to aspects related to public health<sup>20</sup>.

In general terms, there are different approaches to examine the feasibility of different procedures in health actions. There are cases in which the intention to examine the feasibility of use is made explicit, however only parameters related to the production of results are examined or there is no clarity about the parameters that relate to the execution of the technique<sup>21,22,23</sup>.

In the present study, although the production of data about posture issues was also considered, the concern was focused on the possibility of effectively executing the examination strategy in the school environment. Thus, it was adopted as a strategy to establish, a priori, the parameters that define feasibility.

SMT is a technique for studying surface topography and deformation in three dimensions, of practical value recognized for some time<sup>13,15,18,19</sup>. It is also known that it presents scientific authenticity for examining the topography of the body surface<sup>13</sup>. The results obtained in this investigation indicate that the referred technique is feasible to perform periodic screening in children and adolescents in public schools.

It is worth emphasizing that SMT makes it possible to obtain objective data about the current postural status and its filing, so that it is possible to make future comparisons and examine the evolution of the condition. The results obtained in this type of procedure produce important information that can be used to support the development of strategic actions to be used in the development of public policies aimed at promoting health in the school environment.

Despite only showing a suspicion of postural deviations, SMT is seen as an alternative and complementary method for clinical diagnoses, especially those related to postural changes in the trunk<sup>13,14,15</sup>.

In this study, it was confirmed that the technique, in fact, is low-cost, has an accessible technolog-

ical base and is easy to learn and handle, in addition to the low time demand for data collection and processing. Such characteristics make it possible to assume that its application does not require extensive training periods or high professional qualification, thus allowing periodic use in the school environment. It is also noteworthy that it does not require the provision of ample space or sophisticated infrastructure, but it can be done in smaller environments, compatible with the characteristics of public-school classrooms.

Other important aspects about the use of the Moiré technique in periodic screenings in the school environment refer to the fact that the examination of the postural status is done through the observation of objective indicators and that the registration of the processed image can be archived. This allows the results obtained in a test to be compared with those of previous collections, making it possible, therefore, to perform longitudinal comparative exams in order to obtain information about points related to the scope of personal and public health, such as: variation in incidence and prevalence, rate of progression of the postural status found and effectiveness of preventive strategies and/or therapeutic actions, among others.

In addition to technical issues, it is important to note that the school system already has Physical Education teachers in the staff of public schools since the first grade of elementary school. These professionals receive, during their regular academic training, information and technical training to develop all the procedures necessary to carry out postural exams.

As for the production of data, the use of the instrument also proved to be effective. A percentage greater than 70% was identified for the two categories of postural deviations investigated, that is, the presence of fringe difference in the dorsal region and the scapular girdle. These data suggest a high prevalence of postural changes in the target population.

Considering the profile of the individuals treated in the study, from the public health perspective, the results obtained raise concern<sup>1,2,4,5,6,7</sup>. The findings are in line with studies that also investigated postural deviations in schoolchildren and that point to a prevalence of 40% to 80% in the respective sam-

ples<sup>24,25,26</sup>. Populations of school children and adolescents in the Brazilian territory between 7 and 16 years were examined, representing a profile similar to the subjects treated in the present study. However, other investigations carried out also in the country<sup>27,28</sup> have identified significant percentages of prevalence of postural deviations in young adults, which indicates the possibility that, in Brazil, the involvement by postural deviations is not restricted to individuals of the age group observed in this research.

The high number of suspected postural deviations identified can be explained for some reasons, which are directly associated with the profile of the examined sample. The fact that they are school children and adolescents and with an average age of 11.5 years old represents the characteristics of a population that presents trends to the development of postural deviations.

The literature describes that, in the childhood and adolescence, the individual's postural habits are influenced by intrinsic and extrinsic aspects, with emphasis on the hereditary, those arising from the configuration of the surrounding environment, those of an emotional, socioeconomic nature and those arising from natural changes inherent to growth and maturation<sup>3,4,5,10</sup>.

In addition, during the school phase, it seems to be common to adopt incorrect postures arising from the use of inappropriate school furniture (with a single dimension for all individuals) or the transport of school materials<sup>29</sup>, a situation already discussed in previous studies<sup>30</sup>. Based on the relationship between body posture and ergonomic standardization found in study centers such as schools and universities, it is possible to assume the occurrence of different problems resulting from the acquisition, maintenance or worsening of inappropriate postural habits<sup>4,29</sup>.

Although Brazilian studies bring similar findings, other investigations do not corroborate these results, since they point to a wide range of 1% to 38% prevalence in postural deviations<sup>31,32,33</sup>. Nevertheless, although the populations examined are also made up of schoolchildren, the screenings were carried out in several geographical regions. This may explain the

discrepancy between these findings and reinforces the suspicion that different socioeconomic and geographic aspects may contribute to the different prevalence found in the studied populations, since they are distinct regions of Rio de Janeiro and Brazil, which have different structures, cultural habits and lifestyles.

Besides the sociodemographic aspects, the sample size can also explain the disagreement between the prevalence data found, considering that the screenings were performed with up to 4 thousand subjects<sup>3,32,33</sup>, whereas the present study examined a sample number of 304 students.

Importantly, this study presented as a limitation the performance of postural exams in only one public school in Rio de Janeiro, with a sample selected for convenience, which is why it is difficult to generalize the results to the population of schoolchildren in the city. Added to this is the fact that factors equivalent to students' postural habits were not identified, such as transportation of school supplies or ergonomic elements of furniture, which would make it possible to make an association with the high prevalence found.

## CONCLUSION

The present study demonstrated that SMT is feasible in the school environment, as it presented the necessary criteria for periodic posture examinations in children and adolescents from the public network of Rio de Janeiro.

The technique allows the capture of specific and objective data about the behavior of variables that indicate the postural state of the spine and other body segments. In addition, it makes it possible to record these indicators, enabling comparisons between the results of periodic examinations in order to estimate the evolution curves of the observed cases.

The high prevalence of postural deviations identified in this research, combined with the feasibility of SMT in the school environment, confirms the importance of implementing preventive actions in the health of children and adolescents. Added to this is the fact that the school already has installed technical capacity and has a Physical Education teacher in its staff, who is trained to work in health promotion.

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