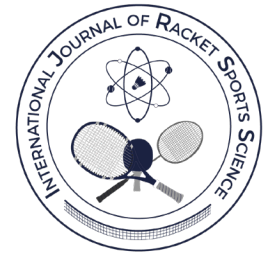


# Tennis and scoliosis: an approach without prejudice

## Tenis y escoliosis: un abordaje sin prejuicios



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### Abstract

This contribution intends to offer a concise and exhaustive overview of the scientific production on the topic, as well as to provide researchers with theoretical reflections, scientific hypotheses and what can be deduced from the personal baggage of experience in the field, albeit limited. All permeated by the hope that future epidemiological investigations will be conducted, compared to the past, with greater methodological rigor and with a more coherent and incisive *modus operandi*. It is unfortunately undeniable that until today the medical sciences have not been able or able to deal with the topic except in a fragmentary manner and with sometimes questionable criteria. The consequences? Few valid studies and too many hasty judgments. Judgments that have not infrequently been affected by a certain habit of our time: a sterile prevalence of discussions and abstractions of a physiopathological type, without the necessary attention to “evidence-based medicine” (Lisi, 2018).

**Keywords:** *tennis, spine, scoliosis, evidence-based medicine.*

### Resumen

Esta contribución pretende ofrecer un panorama conciso y exhaustivo de la producción científica sobre el tema, así como brindar a los investigadores reflexiones teóricas, hipótesis científicas y lo que se puede deducir del bagaje personal de experiencia en el campo, aunque limitado. Todo ello impregnado de la esperanza de que las futuras investigaciones epidemiológicas se realicen, en comparación con las pasadas, con mayor rigor metodológico y con un *modus operandi* más coherente e incisivo. Lamentablemente es innegable que hasta el día de hoy las ciencias médicas no han podido ni han podido tratar el tema sino de manera fragmentaria y con criterios a veces discutibles. ¿Las consecuencias? Pocos estudios válidos y demasiados juicios precipitados. Juicios que no pocas veces se han visto afectados por cierta costumbre de nuestro tiempo: un estéril predominio de discusiones y abstracciones de tipo fisiopatológico, sin la necesaria atención a la “medicina basada en la evidencia” (Lisi, 2018).

**Palabras clave:** *tenis, columna vertebral, escoliosis, medicina basada en la evidencia.*

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## UNCERTAINTY SINCE THE DAWN OF TIME

Given the purely asymmetrical nature of tennis activity, a scoliotic boy was required to direct his future physical-motor and sporting training above all towards swimming disciplines, to which considerable therapeutic properties have been attributed. Scientific evidence does not support the assumption. Some research (Vercauteren et al., 1982; Geyer, 1986) have in fact demonstrated the groundlessness of this belief. In summary, swimming excludes any postural reconstruction due to the impossibility of leveraging on static and stable fixed points of reference and, mechanically, it does not allow to control the torsions of the spine, the inevitable anteversions of the pelvis and the equally inevitable traction vector forces of the back muscles (Lisi, 2018; Lisi & Giuffrida, 2019). On the other hand, however, since there are no rigorous scientific studies, a direct influence of racket sport cannot be excluded a priori, especially if this sporting activity is performed for many hours a day as in the case of young competitive tennis players (Lisi, 2018). Among other things, competitive activity, which today tends to start at an increasingly immature age and is continued for two-three hours a day in the years of growth, can lead to an asymmetrical strengthening of the muscle groups of the shoulder girdle and of the upper limb on one side (as usually occurs and is evident in young champions), while the other side has no other role than that of lifting the ball in the gesture of the service (Figure 1). But all this, it can be countered, has never been sufficient to induce a developmental rachis deformation. To about, it is necessary to use the term “evolutionary” correctly, since the worsening in the course of growth is an indispensable requirement to be able to speak of “true scoliosis”. Otherwise, we can only speak of a spine deviation secondary to asymmetrical muscular development, clearly non-evolutionary and not dissimilar from what is observed in the (rather rare, but well-known) cases of agenesis of a pectoralis major or in the much more frequent cases of hypometry of the lower limbs (Lisi, 2018).

## FEW STUDIES AND NOT VERY RELIABLE: WHY IS THE CROSS-SECTIONAL STUDY USED?

Reviewing the available scientific literature, we could not fail to notice the presence of few studies, and of those few almost all referable to “cross-sectional study”. The methodology used allows us to detect only the prevalence and it is not possible to talk about risk, protective or irrelevant factors. In other words, the aforementioned parameters are demonstrated only with a prospective case-control or cohort study, i.e. a study that allows verifying the onset of the disease among those exposed.

It is worth remembering that several critical issues are observed in the choice of study design and its consequences:

- They collect information relating to exposure to risk factors and their outcomes (onset of the disease) at the same time and on the same patient. They can be thought of as a snapshot of a disease in a population at a particular time. However, given that the exposure and the disease state are measured at the same instant in time, it is not possible with this type of study to establish a cause-effect relationship between exposure to the risk factor and onset of the disease, but only a possible association, since the temporal component is missing. This is why they are often used only initially, and then carry out case-control or cohort studies;
- They offer immediate results and are economically irrelevant as they do not require the use of resources, time and personnel for long periods (unlike case-control or even more cohort studies);
- They are useful for exploring the distribution of a disease at time “0”, the association between disease and random factor; they can be considered as a first phase of a study to be explored in depth with other types of designs (case-control or cohort).

Some of the most reliable studies are reported in the next section. Or, better said, those reported in indexed journals but unfortunately not free from methodological and content errors. We wanted to proceed through the so-called “Narrative review” which give a panoramic view of a given topic, generally addressing every aspect of it.

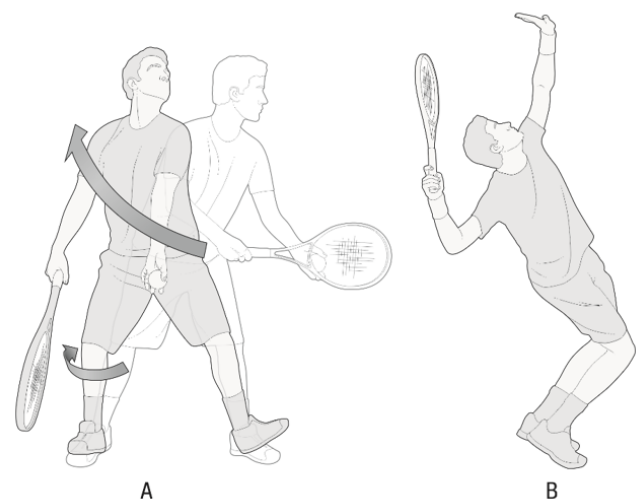


Figure 1. After assuming the position to serve, tennis player carries out the entire loading phase of the game start shot. This phase consists first of all in rotating the trunk around the longitudinal axis in the direction of the arm-racket (Figure 1A), and finally in flexing the legs simultaneously with throwing the ball with the non-dominant hand: the player will thus come to be in the so-called loading position or, also, “trophy position” (Figure 1B).

## THE LITERATURE IS CLEAR: FEW STUDIES AND IRRELEVANT STUDY DESIGNS

### Study by Zaina and colleagues (Italy)

Zaina and colleagues (2016) proposed a study to verify the prevalence of spinal asymmetries, deformities and low back pain in adolescents who play tennis at a competitive level, compared with healthy controls. Beyond some several critical issues (i.e. software used to carry out the analysis was not reported, nor whether or not the normality of the data was tested) it is not clear why a control group was taken, as it was not covered by this type of study. Furthermore, in the text they are defined as “healthy controls”, when instead it is expressly stated that for the choice of this group no restriction was placed either on the type of sport practiced or on a previous diagnosis of disease. In the “Discussions” section it is stated that, from the results achieved, the idea that tennis is traditionally considered as a sport that can damage the spinal column and increase the risk of spinal deformities is rejected, as a similar prevalence in the two groups compared. This type of conclusion cannot be reached with the study design used, but rather with a case-control or cohort. At the same time, it is rightly said later that, due to the type of design used, we cannot establish a cause-effect relationship, but simply a correlation, awaiting future studies. In the “Conclusions” the lack of association between Tennis and LBP is rightly reiterated. Given the correct conclusions, and the way of interpreting the results, the title of this work is misleading as it seems to establish a cause-effect relationship by asserting the non-dangerousness of tennis for pathologies related to the spine during growth. In our opinion, a title like “Tennis is not related to pathologies related to the spine during growth: results of a cross-sectional study” would have been more correct (even if less captivating and/or media-expressive).

### Study by Gallotta and colleagues (Italy)

Gallotta and collaborators conducted a study (Gallotta et al., 2015) on a sample of tennis students from the sports group belonging to their university and divided into two groups: the first, made up of competitive level players; the second, by amateur level players. The experimental study of the work involved two evaluation sessions using raster stereography on tennis players before and after two types of training of equal duration on the court: the first training based on baseline shots and the second composed mainly of overhead shots (serve, volley and smash). The results showed how the competence factor, i.e. belonging to the group of agonists or amateurs, influenced two of the numerous parameters measured: the lateral deviation of the spine and the angle of rotation. In this case, the competitive group showed - for these two parameters - higher values than the amateurs,

indicating an adaptation of the spine in both lateral inclination and torsion, reasonably linked to the years of tennis practice. However, these values were close to the normal physiological range, suggesting, indirectly, that competitive practice per se is not a factor directly linked to spinal asymmetry. Finally, between the two different sessions, the one focused on overhead shots produced higher lateral deviation values (particularly on the left side), indicating that it produces greater stress on the spine than the one based on groundstrokes.

This study indicates that a single gaming session can still produce acute effects, identifiable as adjustments to the spine; but that, in fact, no measured parameter was significantly altered. Compared to the multi-year practice of tennis, the values of the agonists slightly higher than the physiological range seem to confirm that tennis is not in itself a predisposing factor to body asymmetries. In conclusion, the acute effects are not such as to lead us to consider tennis a contraindicated sport for those suffering from mild scoliosis or simple scoliotic aptitudes. The study made use of a non-invasive technique, which reconstructs the dorsal-lumbar spine starting from the superficial analysis of the morphological profile and which would allow a sufficiently accurate and repeatable evaluation, as we read in another work by the same authors (Guidetti et al., 2013), called “rasterstereography”. Aside from the critical issues of the study design, the use of rasterstereography itself does not yet convince the scientific community: although the first meta-analysis on the reliability and validity of rasterstereography showed satisfactory results (Krott, Wild & Betsch, 2020), further studies are needed, focusing on the properties of both static and dynamic raster-stereographic measurements.

### Study by Swärd and colleagues (Sweden)

In their study, Swärd points out that scoliosis was found in over 80% of subjects who practiced typically asymmetric activities, such as tennis (Swärd et al., 1990). The scholar specifies, however, that in these cases it is perhaps unjustified to speak of true scoliosis, as these are very modest forms, but at the same time recognizes that it would be simplistic to define them as simple functional scoliosis. In the case of tennis players, Swärd was able to establish, together with some colleagues, that there was a rotation of the vertebral bodies and, therefore, one of the fundamental characteristics of scoliosis. Furthermore, the rotation was accompanied by a curve that did not exceed, in any of the athletes examined, 15°: out of a total of 30 male professional tennis players, aged between 17 and 25 years, only 4 (13.3 %) presented a frank scoliotic picture, ascertained by radiographic examination. In order to be used correctly, the term scoliosis should exclusively refer to conditions of true scoliosis, the specific characteristic of which is that of being permanent and evolutionary. Strictly speaking, therefore, not even the alterations (13.3%) detected by

Swärd are to be considered real scoliosis, since it is the Swedish scholar himself who states: «This type of scoliosis is not evolutionary. In my opinion, evolution depends on the load supported by the spinal column during growth. At the end of growth, or when the individual stops practicing tennis, evolution stops. If the pressure on the growth plate (or part of it) is high, growth slows down, while tensile forces accelerate it. During tennis practice, a torsional load is applied to the spine which causes minor scoliosis» (Swärd, 2002). In conclusion, “minor scoliosis”, although not in itself evolutionary, could however become so if associated with a particular type of load and, therefore, sporting activity. Given that in the context of the sport of tennis the spine is reasonably stressed by asymmetric torsion and flexion movements, a consequent asymmetric development of the vertebrae in accordance with the Hueter-Wolkman law is conceivable. This law constitutes the principle on which the construction of corsets for the bloodless treatment of structured scoliosis is based. Swärd’s analysis is however very clear regarding the prognosis for the evolution of scoliosis during growth: one of the conditions for the scoliotic evolution to stop is the interruption of tennis practice. That said, Swärd’s contribution, in some respects meritorious, is far from explaining the effects of physical exercise on the spine in young athletes. In fact, despite some subsequent considerations by the author, research focused on tennis has involved male individuals, almost all with complete bone maturity (Risser=5).

### Study by Dalichau and Scheele (Germany)

The aim of the study was to verify the existence of a relationship between the mechanical-dynamic commitment in competitive tennis and the thoracic and lumbar profile of the spine (Dalichau & Scheele, 2002). The study, which lasted 5 years (1995-2000), involved athletes from 9 sports disciplines. Below we report the results relating to athletes who practiced tennis at a competitive level. Of the 1470 male subjects, 123 were competitive tennis players (23.8±4.5 years; 181.5±5.3 cm; 76.4±6.3 kg), with a training frequency of 7.5± 1.9 hours/week, while the remaining 1347, part of the control group, were subjects who practiced sports at an amateur level or who did not practice any sport (24.2±4.1 years; 179.6±9.5 cm; 79.2±8.6 kg). In the sagittal projection, no significant or trend differences emerged between the two groups, nor did the group of tennis athletes split into subgroups according to the criteria of “dominant arm”, “serving technique” and “type of player”. had an impact on the data relating to the dysmorphisms covered by the research (kyphosis, lordosis and inclination). Instead, the dominance of the arm with which the racket was held induced statistically significant differences on all the relevant parameters for the description of the shape of the spinal column on the frontal and transverse planes, in which the angles measured in the competitive athletes

were greater than in the group control. Furthermore, the technique of executing the two-handed shots, both forehand and backhand, caused a further clear increase in the values detected (lateral inclination of the spine, inclination of the pelvis and shoulder/pelvis and shoulder/pelvis rotation). The investigation made use of a device, patented by the German company “Zebris”, which is based on an ultrasonic targeting system. Regarding the validity of the system, the authors cite one study (Schreiber, Anders & Katterwe, 1998). Unfortunately, the same critical issues reported for ratereography remain. Among other things, some authors (Takács et al., 2013), who used the “winspine measurement software” developed specifically for the “Zebris CMS-HS measurement system”, despite the excellent results (strong correlation with the values calculated from the rays using the Cobb technique), they clearly state that “[...] the accurate assessment of the degree of scoliosis can only be done with an Xray” (Takács et al., 2013). It should be remembered that studies based on objective and non-invasive detection procedures, due to the use of different equipment and the absence of quantitative results, cannot be compared and consulted for further research. Among other things, the number of the sample examined is very limited while the age of the players involved in the program did not concern the so-called period of rapid spinal growth, where scoliosis appears more frequently and where it tends to evolve more quickly. It would have been more useful to evaluate whether boys (especially girls, given the presence of menarche) between the ages of 10 and 14, with or without scoliosis, had developed –or worsened– this deformity.

### CONCLUSION

As can be seen in this contribution, the articles present in the literature are few, and those few are not very reliable. The cohort study, certainly the most accurate, requires scrupulous planning, a very large population to be sampled and an availability of resources such as to make its implementation practically prohibitive.

The case-control approach, on the other hand, might be less difficult. It consists in recruiting a group of subjects with scoliosis, possibly (although not necessarily) accidents, to avoid changes in behavior and possible “bias” of information, and an adequate number of checks. Another approach, much more expensive and with a greater risk of bias from non-responders, is the population case-control study, where the controls are selected from the general population with a randomized procedure (simple, or with matching according to the characteristics of the cases): this selection can take place, for example, by drawing on the database of the health register. In the case in question, it would be necessary to pay close attention to any selection bias or confounding due, in particular, to the fact that the subjects who practice the sport of tennis generally belong to medium or



high social strata, which could possess characteristics different from general population (take into account greater diagnostic attention, with overestimation of the occurrence of scoliosis, different risk factors - or rather protective ones - for the same pathology).

It should also be kept in mind that any research must in any case be subjected to rigorous biomechanical studies that also take into account the “kinetic chains”, i.e. the movements and muscle activation “upstream and downstream”. These studies, in turn, will make use of suitable instrumentation, such as surface EMG, optoelectronic systems for 3D movement analysis and complex biomechanical models: all, obviously, in relation to the morphotype, the racket and the degree of tension of the stringing. And, obviously, in line with the principles of the now well-known “evidence-based medicine” (the so-called “Medicine based on evidence of efficacy”, and not on evidence, as some authors erroneously continue to report), future publications scientific evidence will require objective and repeatable evidence (Lisi, 2018).

### Reflections and operational proposals

Although some specialists even believe that «[...] in the presence of right dorsal, right dorsal-lumbar or right dorsal and left lumbar scoliosis with rotation, the torsional deformity, in some cases, may even have a benefit due to the traction on the spine produced by the movements of the upper limb (which is almost always the right) mainly due to the serratus major and the abdominal obliques» (Pirola, 1994), we do not believe it is possible to reach a definitive conclusion on the relationship between tennis and scoliosis. For the times, methodologies and costs that the types of studies mentioned above require. It is difficult to imagine the possibility of a serious, long-term study using, among other things, x-graphy as an evaluation methodology. No parents would agree - rightly - to entrust their child to repeated x-ray examinations, also given the close relationship between the use of radiation and the onset of tumors (Doody et al., 2000).

And then, even if science might object, it is necessary to rely on common sense, as there is no data to support it. A serious professional, infused with notions of anatomy, biomechanics and muscular physiology and positively open to collaboration with other professional figures, will take responsibility for whether or not a scoliotic individual can practice tennis (each individual case is unique and requires a different approach and in relation to different factors).

However, let's try to answer some frequently asked questions asked by professionals. For example, doesn't mild scoliosis cause harm to competitive tennis players? Unfortunately, the answer will have to wait for more convincing studies. There are many, too many parameters to take into due consideration. These include: chronological age; position of the scoliotic curve (lumbar, thoracolumbar, thoracic, etc.); severity

of the scoliotic curve; intensity of tennis activity and, unfortunately, also gender. In fact, several studies (Suh et al., 2011; Daruwalla et al., 1985; Lonstein, Bjorklund & Wanninger, 1982; Rogala, Drummond & Gurr, 1978; Asher, Green & Orrick, 1980) report about higher Cobb angles in girls than in boys, indicating that scoliosis in girls progresses to a higher grade of severity. For patients with a Cobb angle of more than 30° the prevalence ratio gets as high as 10:1 (Soucacos et al., 1997; Weinstein et al., 2008; Raggio, 2006; Luk et al., 2010).

Structured scoliosis certainly determines a series of obvious anatomical-functional limitations that would discourage the practice of competitive tennis. In essence, it involves subjecting a spinal column that is fragile in itself (factors that determine idiopathic scoliosis are numerous and partly unknown) to loads that are perfectly bearable by “normal” spinal columns. In other cases, fortunately much more numerous and frequent (i.e. cases in which the scoliosis has not reached a recognized severity and tennis is practiced only at an amateur level), the subject's condition can coexist with the presence of this deformity, without neglecting scientifically targeted and disciplined kinesitherapy (Lisi, 2018), based on compensatory exercises of the upper limb and the contralateral shoulder girdle but, above all, on core strengthening exercises, so as to build a “supportive muscular torso”, that could conceivably protect spine from the insults of tennis practice.

### CONFLICTS OF INTEREST

Authors declare the absence of conflicts of interest.

### FUNDING

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