

This is a provisional PDF only. Copyedited and fully formatted version will be made available soon.



**DISASTER
AND EMERGENCY**

M E D I C I N E J O U R N A L

Epidemiology of limb injuries in pediatric patients receiving care from Emergency Medical Service teams: descriptive analysis

Authors: Kamil Safiejko, Marek Malysz, Lukasz Szarpak, Jerzy Robert Ladny

DOI: 10.5603/DEMJ.a2019.0028

Article type: ORIGINAL ARTICLES

Submitted: 2019-10-09

Accepted: 2019-10-15

Published online: 2019-10-30

This article has been peer reviewed and published immediately upon acceptance. It is an open access article, which means that it can be downloaded, printed, and distributed freely, provided the work is properly cited.

EPIDEMIOLOGY OF LIMB INJURIES IN PAEDIATRIC PATIENTS RECEIVING CARE FROM EMERGENCY MEDICAL SERVICE TEAMS: DESCRIPTIVE ANALYSIS

Kamil Safiejko¹, Marek Malysz², Lukasz Szarpak², Jerzy Robert Ladny¹

¹Department of General and Endocrinological Surgery, Medical University of Białystok, Poland

²Lazarski University, Medical Faculty, Warsaw, Poland

ABSTRACT

INTRODUCTION: Injury-related interventions currently place a heavy workload on emergency medical teams in both adults and paediatric patients. One of the most common types of injuries are limb injuries caused by physical activity, falls or traffic accidents. It is extremely important to provide adequate protection for the paediatric patient in case of injury, as homeostasis disorders can occur very quickly in this age group.

The aim of the study was to obtain data on the type and frequency of limb injuries in the group of paediatric patients who received medical rescue services interventions. An attempt was also made to specify the most frequent causes of limb injuries.

MATERIAL AND METHODS: The study was based on a retrospective analysis of medical records of emergency rescue teams in the period from November 2017 to October 2018. The study included an analysis of interventions to patients under 18 years of age to whom EMS teams intervened due to limb injury. The analysis included sociodemographic data such as age, gender, time and place of the injury, as well as the type of injury based on the ICD-10 classification.

RESULTS: In the studied period, 289 interventions in paediatric patients with limb injuries were recorded, which constituted 9.8% of all interventions in paediatric patients. The main site of the injury was a school. Upper limb injuries were reported in 123 cases, which constituted 42.6% of the intervention to the studied group of patients. The upper limb injuries were predominantly caused by forearm fractures ($n = 33$; Tab. 3), while the lower limb — by knee joint injuries.

CONCLUSIONS: Limb injuries account for nearly 10% of all EMS interventions in paediatric patients. The main site of the injury was a school and the most frequent were upper limb injuries including forearm fractures, while for the lower limb — knee joint injuries. Further action should be taken to reduce the number of limb injuries in children.

KEY WORDS: limb; trauma; injury; prehospital care; emergency medicine service; emergency medicine

Disaster Emerg Med J 2019; 4(4): 1–7

INTRODUCTION

Injury-related interventions currently place a heavy workload on emergency medical teams in both adults and paediatric patients. Injuries to children

are a very important reason for visiting emergency departments and hospitalization. Children's injuries have different causes and, depending on the severity and location of the injury and co-morbidities, maybe

ADDRESS FOR CORRESPONDENCE:

Lukasz Czyzewski, Department of Nephrology Nursing, Medical University of Warsaw, Oczki 8 Str. 02–007 Warsaw, Poland;
e-mail: czyzewski_lukasz@wp.pl

a significant cause of mortality and chronic health disability. Limb injuries occur in children in different age groups, and the age of children may influence the location of injuries and their characteristics [1]. The occurrence of injuries is influenced by many factors related to parental care, environmental exposure, sport and physical activity [2]. In some parts of the world, violence and ongoing military activities are an important factor in child injuries [3].

One of the most common types of injuries are limb injuries caused by physical activity, falls or traffic accidents. Injuries caused by sport practised by young people are of special importance [4] due to the different characteristics of the injuries, for example injury rates can be greater in collegiate versus high school baseball and in competition versus practice [5]. The number of injuries to children is evidenced by the fact that on average, a child is treated in a US emergency department for a nonfatal consumer product- or sports and recreational activity-related injury every 6 seconds [6]. One of the causes of limb fractures in children can be abuse — especially common among infants [7]. Also, mistakes committed by parents and guardians of children can cause a problem [8]. It is extremely important to provide adequate protection for the paediatric patient in case of injury, as homeostasis disorders can occur very quickly in this age group. There are large differences in the mechanisms of injury, injury response, clinical signs and results of image examinations in adults and children. Injuries in children, especially in extreme age groups, require in-depth clinical evaluation and specialist consultation. In many countries, the cost of treating injuries in children and, above all, the cost of further treatment and rehabilitation are being raised [8].

The aim of the study was to obtain data on the type and frequency of limb injuries in the group of paediatric patients who received medical rescue services interventions. An attempt to specify the most frequent causes of limb injuries was also made.

METHODS

The study was designed as a retrospective study of medical records of medical rescue teams from Piaseczno, Grodzisk Mazowiecki and Pruszków districts. The study protocol was approved by the Institutional Review Board of the Polish Society for Disaster Medicine (Approval number: 32.02.2018.IRB).

We analysed paediatric patients transported by a countywide EMS system between November

2017 and October 2018. The EMS catchment area includes urban, suburban, and rural areas over approximately 1234 square kilometres containing officially a population of 437 thousand people. However, the official population statistics are understated as the survey areas are a kind of accommodation for Warsaw. Thus, the real population may exceed one million people.

Special attention has been paid to the main socio-demographic features such as age, gender, location of the injury and other circumstances of the injury such as time and place of occurrence. All diseases are classified according to the International Statistical Classification of Diseases and Related Health Problems, Revision X (ICD-10).

The material was subjected to basic statistical analysis with the use of Statistica 13.3EN and MS Office Excel 2010, calculating basic descriptive statistics. For statistical comparisons, we used Fisher's exact test for qualitative variables and Student's test for quantitative variables. Values of $P \leq 0.05$ were considered significant.

RESULTS

Population characteristics

In the period under study, medical rescue teams performed 42 482 interventions, of which 2942 were performed in patients under 18 years of age. Of all the interventions performed in paediatric patients, 9.8% ($n = 289$) were interventions for limb injuries.

The majority of the patients were males, accounting for 59.9% of the studied group. The mean age of the study group was 11.4 ± 3.9 years and was slightly higher for boys than girls (11.4 ± 3.9 vs. 11.3 ± 3.8 years, respectively; $p = 0.809$; Fig.1).

The main place of injuries in the study group was a school, then a public place, a house and finally traffic. The detailed characteristics of the study group are presented in Table 1. In the case of injuries at home, they concerned the youngest patients (Fig.2). The median age of boys and girls was 9.3 ± 4.8 vs. 9.3 ± 5.3 years. In the case of public place injuries, the most common among boys was at the age of 12.4 ± 3.7 years, and in the case of girls — 11.1 ± 3.6 years. The age of road traffic injuries was equal for girls and boys (13.1 ± 3.5 vs. 11.5 ± 3.9 years, respectively), and for school injuries, the median age of injured girls was 12.0 ± 2.7 years and for boys 12.2 ± 3.0 years.

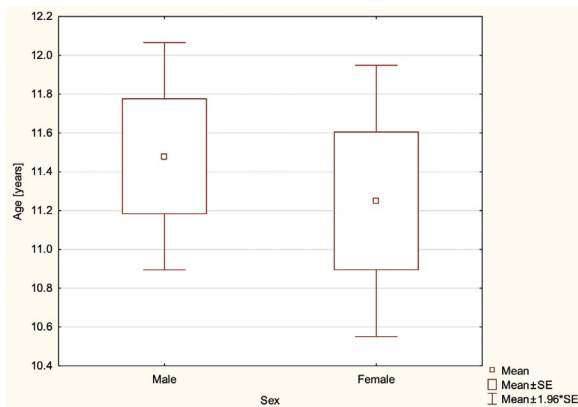


FIGURE 1. Mean age of study participants

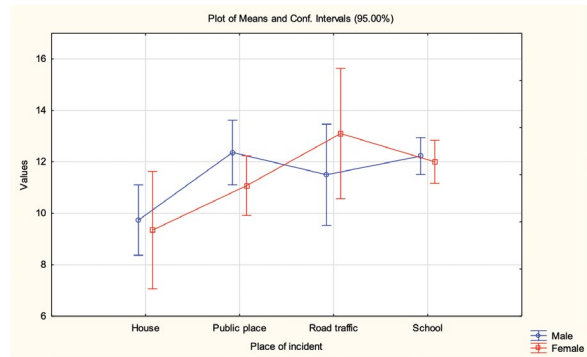


FIGURE 2. The main place of injuries in the study group compared with participants sex and age

Parameter	Total		Female		Male		p-value
	Count	Percent	Count	Percent	Count	Percent	
No. of Patients	289	100%	116	40.1%	173	59.9%	0.812
Age group							
<4	20	6.9%	6	5.2%	14	8.1%	0.955
4–7	25	8.6%	13	11.2%	12	6.9%	
8–12	120	41.5%	47	40.5%	73	42.2%	
13–15	56	19.4%	36	31.0%	50	28.9%	
16–18	38	23.6%	14	12.1%	24	13.9%	
Place of injury							
Home	72	24.9%	23	19.8%	49	28.3%	0.388
School	115	39.8%	43	37.1%	72	41.6%	
Public place	76	26.3%	40	34.5%	36	20.8%	
Road traffic	26	9.0%	10	8.6%	16	9.3%	

Characteristics of injuries

Upper limb injuries were reported in 123 cases, which constituted 42.6% of the intervention to the examined group of patients. Upper limb injuries were dominated by forearm fractures ($n = 33$; Tab. 2) and lower limb injuries by knee joint injuries (Tab. 3). No statistically significant influence of gender on the type of injury was observed. The relationship between the age of sex and the type of injury is shown in Figure 3.

The time frame of the injury

Most injuries occurred in the afternoon between 12:00 and 18:00. 45.3% of all injuries analysed in the study group occurred in the afternoon (Tab. 4).

A detailed weekly distribution of injuries is shown in Table 4. The most frequent injuries occurred on Thursday and Friday. There were no significant differ-

ences in the incidence of injuries between girls and boys in relation to the day of the injury ($p = 0.910$), month ($p = 0.472$) or season ($p = 0.192$).

DISCUSSION

The study analysed the documentation of medical records of emergency medical rescue teams that intervened in paediatric patients due to injuries to upper and lower extremities. In our study, 9.8% of all the interventions performed in paediatric patients were interventions for limb injuries. This implies that emergency medical teams must be prepared to provide assistance in such cases. Given the number of interventions in children, limb injuries are a heavy burden for both emergency departments and paediatric surgery departments [9].

Table 2. Characteristics of upper limb injuries							
Parameter	Total		Female		Male		p-value
	Count	Percent	Count	Percent	Count	Percent	
Shoulder and upper arm injuries							
S40 Superficial injury of shoulder and upper arm	5	1.7%	3	2.6%	2	1.2%	0.425
S41 Open wound of shoulder and upper arm	2	0.7%	-	-	2	1.2%	
S42 Fracture of shoulder and upper arm	4	1.4%	1	0.9%	3	1.7%	
S43 Dislocation, sprain and strain of joints and ligaments of the shoulder girdle	4	1.4%	-	-	4	2.3%	
S49 Other and unspecified injuries of shoulder and upper arm	12	4.2%	3	2.6%	9	5.2%	
Total	27	9.3%	7	6.0%	20	31.6%	
Forearm injuries							
S50 Superficial injury of forearm	8	2.8%	3	2.6%	5	2.9%	0.117
S51 Open wound of forearm	10	3.5%	5	4.3%	5	2.9%	
S52 Fracture of forearm	33	11.4%	14	12.1%	29	17.8%	
S53 Dislocation, sprain and strain of joints and ligaments of elbow	4	1.4%	-	-	4	2.3%	
S59 Other and unspecified injuries of the forearm	14	4.8%	4	3.4%	10	5.8%	
Total	69	23.9%	26	22.4%	53	30.6%	
Wrist and hand injuries							
S60 Superficial injury of wrist and hand	11	3.8%	6	5.2%	5	2.9%	0.207
S61 Open wounds of wrist and hand	1	0.3%	-	-	1	0.6%	
S62 Fracture at wrist and hand level	5	1.7%	3	2.6%	2	1.2%	
S67 Crushing injury of wrist and hand	2	0.7%	-	-	2	1.2%	
S68 Traumatic amputation of thumb wrist and hand	2	0.7%	1	0.9%	1	0.6%	
S69 Other and unspecified injury of wrist and hand	6	2.1%	-	-	6	3.5%	
Total	27	9.3%	10	8.6%	27	15.6%	

In our study group, the majority of the patients with limb injuries were males, accounting for 59.9% of the studied group. This is related to the higher physical activity of boys and is consistent with the results of other studies including studies on adolescent lifestyle patterns [10]. Issin et al. analysed paediatric fractures in the metropolitan area of Turkey [11]. They

similarly showed that 65% of the paediatric patients with fractures were males and 35% were females.

Our study revealed that the mean age of paediatric patients with limb injuries was equal for boys and girls (11.4 ± 3.9 vs. 11.3 ± 3.8 years, respectively) however, at this age the physical activity of girls and boys may be at a similar level.

Table 3. Characteristics of lower limb injuries

Parameter	Total		Female		Male		p-value
	Count	Percent	Count	Percent	Count	Percent	
Hip and thigh injuries							
S70 Superficial injury of hip and thigh	11	3.8%	5	4.3%	6	3.5%	0.774
S71 Open wound of hip and thigh	4	1.4%	2	1.7%	2	1.2%	
S72 Fracture of femur	2	0.7%	1	0.9%	1	0.6%	
S73 Dislocation, sprain and strain of joint and ligaments of hip	1	0.3%	-	-	1	0.6%	
S76 Injury of muscle and tendon at hip and thigh level	1	0.3%	1	0.9%	-	-	
S79 Other and unspecified injuries of hip and thigh	5	1.7%	-	-	5	2.9%	
Total	24	8.3%	9	7.8%	15	8.7%	
Lower leg injuries							
S80 Superficial injury of lower leg	8	2.8%	6	5.2%	2	1.2%	0.351
S81 Open wound of lower leg	15	5.2%	2	1.7%	13	7.5%	
S82 Fracture of lower leg, including ankle	5	1.7%	-	-	5	2.9%	
S83 Dislocation, sprain and strain of joints and ligaments of the knee	30	10.4%	15	12.9%	15	8.7%	
S89 Other and unspecified injuries of the lower leg	18	6.2%	6	5.2%	12	6.9%	
Total	76	26.3%	29	25.0%	47	27.2%	
Ankle joint and foot injuries							
S90 Superficial injury of ankle and foot	11	3.8%	4	3.4%	7	4.0%	0.097
S93 Dislocation, sprain and strain of joints and ligaments at ankle and foot level	14	4.8%	7	6.0%	7	4.0%	
S96 Injury of muscle and tendon at ankle and foot level	6	2.1%	-	-	6	3.5%	
S99 Other and unspecified injuries of ankle and foot	35	12.1%	16	13.8%	19	11.0%	
Total	66	22.8%	27	23.3%	39	22.5%	

In our study the main place of injuries in the study group was a school, then a public place, a house and finally traffic. a school is a place where the child spends a considerable amount of time. School not only provides physical education but also encourages kids to spontaneously play team games and engage in physical activities [12]. The available results indicate a wide variety of trauma locations in children and their relationship to the type of injury.

Upper limb injuries were reported in 42.6% of the intervention to the examined group of patients. Upper limb injuries were dominated by forearm fractures and lower limb injuries by knee joint injuries. Available studies have shown that the location of injuries depends on the mechanism of its occurrence, particularly in road traffic accident victims [13].

In our study, most injuries occurred in the afternoon between 12:00 and 18:00. it is most similarly

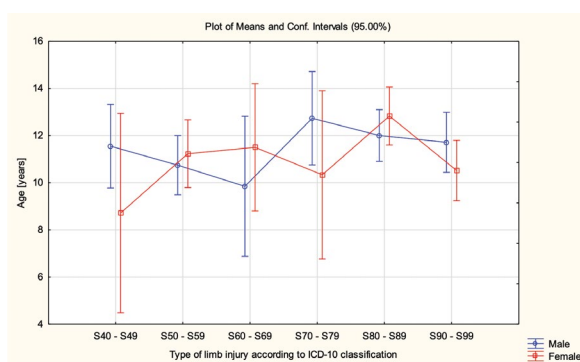


FIGURE 3. The type of injuries in the study group comparing with participants sex and age

related to children taking up physical activity immediately after school, during a long break and on their way home from school and in the afternoon before sunset. 45.3% of all injuries analysed in the study group occurred in the afternoon and the most frequent injuries occurred on Thursday and Friday, however, there were no significant differences in the incidence of injuries between girls and boys in relation to the day of the injury, month or season. The final days of the week are a period of reducing the burden on children to prepare for the next day's school day, which translates into higher levels of

Table 4. Fluctuations of limb injury							
Parameter	Total		Female		Male		p-value
	Count	Percent	Count	Percent	Count	Percent	
Time of day							
00:01 – 06:00	2	0.7%	-	-	2	1.2%	0.793
06:01 – 12:00	91	31.5%	34	29.3%	57	32.9%	
12:01 – 18:00	131	45.3%	55	47.4%	76	43.9%	
18:01 – 24:00	65	22.2%	27	23.3%	38	22.0%	
Day of week							
Monday	38	13.1%	21	18.1%	17	9.8%	0.910
Tuesday	43	14.9%	16	13.8%	27	15.6%	
Wednesday	48	16.6%	13	11.2%	35	20.2%	
Thursday	54	18.7%	23	19.8%	31	17.9%	
Friday	50	17.3%	16	13.8%	34	19.6%	
Saturday	27	9.3%	12	10.3%	15	8.7%	
Sunday	29	10.0%	15	12.9%	14	8.1%	
Month							
January	19	6.6%	5	4.3%	14	8.1%	0.472
February	13	4.5%	3	2.6%	10	5.8%	
March	29	10.0%	13	11.2%	16	9.2%	
April	16	5.5%	10	8.6%	6	3.5%	
May	43	14.9%	17	14.6%	26	15.0%	
June	37	12.8%	18	15.5%	19	10.9%	
July	21	7.3%	6	5.2%	15	8.7%	
August	20	6.9%	8	6.9%	12	6.9%	
September	15	5.2%	4	3.4%	11	6.4%	
October	27	9.3%	11	9.5%	16	9.2%	
November	21	7.3%	11	9.5%	10	5.8%	
December	28	9.7%	10	8.6%	18	10.4%	
Season							
Spring	88	30.4%	40	34.5%	48	27.7%	0.192
Summer	78	26.9%	32	27.6%	43	24.9%	
Autumn	63	21.8%	26	22.4%	37	21.4%	
Winter	60	20.9%	18	15.5%	42	26.0%	

physical activity. Issin et al. in their analysis paediatric fractures in a metropolitan area of Turkey [11] have shown that fractures in paediatric patients had some seasonal, daily, and circadian variations, similarly as Odetola et al. [9]. This study has its strengths and weaknesses. Among the strengths is the large analysed group. The basic weakness is the retrospective nature of the analysis.

Conclusions

Limb injuries account for nearly 10% of all EMS interventions in paediatric patients. The main site of the injury was a school and the most frequent were upper limb injuries including forearm fractures, while for the lower limb — knee joint injuries. Further action should be taken to reduce the number of limb injuries in children.

REFERENCES:

- Barnard AM, Nelson NG, Xiang H, et al. Pediatric mobility aid-related injuries treated in US emergency departments from 1991 to 2008. *Pediatrics*. 2010; 125(6): 1200–1207, doi: [10.1542/peds.2009-3286](https://doi.org/10.1542/peds.2009-3286), indexed in Pubmed: [20498179](https://pubmed.ncbi.nlm.nih.gov/20498179/).
- Chéron C, Le Scanff C, Leboeuf-Yde C. Association between sports type and overuse injuries of extremities in children and adolescents: a systematic review. *Chiropr Man Therap*. 2016; 24: 41, doi: [10.1186/s12998-016-0122-y](https://doi.org/10.1186/s12998-016-0122-y), indexed in Pubmed: [27872744](https://pubmed.ncbi.nlm.nih.gov/27872744/).
- Er E, Çorbacioğlu ŞK, Güler S, et al. Analyses of demographical and injury characteristics of adult and pediatric patients injured in Syrian civil war. *Am J Emerg Med*. 2017; 35(1): 82–86, doi: [10.1016/j.ajem.2016.10.008](https://doi.org/10.1016/j.ajem.2016.10.008), indexed in Pubmed: [27771222](https://pubmed.ncbi.nlm.nih.gov/27771222/).
- Montgomery C, Porter A, Parks C, et al. Football-Related Pediatric Extremity Fractures and Dislocations: Size Matters. *Orthopedics*. 2018; 41(4): 216–221, doi: [10.3928/01477447-20180628-03](https://doi.org/10.3928/01477447-20180628-03), indexed in Pubmed: [30035799](https://pubmed.ncbi.nlm.nih.gov/30035799/).
- Wasserman EB, Sauers EL, Register-Mihalik JK, et al. The First Decade of Web-Based Sports Injury Surveillance: Descriptive Epidemiology of Injuries in US High School Boys' Baseball (2005–2006 Through 2013–2014) and National Collegiate Athletic Association Men's Baseball (2004–2005 Through 2013–2014). *J Athl Train*. 2019; 54(2): 198–211, doi: [10.4085/1062-6050-239-17](https://doi.org/10.4085/1062-6050-239-17), indexed in Pubmed: [30951387](https://pubmed.ncbi.nlm.nih.gov/30951387/).
- Kamboj AK, Chounthirath T, Hodges NL, et al. Nonfatal Pediatric Injuries Associated With Consumer Products and Sports and Recreational Activities in the United States. *Pediatr Emerg Care*. 2019 [Epub ahead of print], doi: [10.1097/PEC.0000000000001778](https://doi.org/10.1097/PEC.0000000000001778), indexed in Pubmed: [30829840](https://pubmed.ncbi.nlm.nih.gov/30829840/).
- Berthold O, Frericks B, John T, et al. Abuse as a Cause of Childhood Fractures. *Dtsch Arztebl Int*. 2018; 115(46): 769–775, doi: [10.3238/arztebl.2018.0769](https://doi.org/10.3238/arztebl.2018.0769), indexed in Pubmed: [30602409](https://pubmed.ncbi.nlm.nih.gov/30602409/).
- Wegmann H, Orendi I, Singer G, et al. The epidemiology of fractures in infants—Which accidents are preventable? *Injury*. 2016; 47(1): 188–191, doi: [10.1016/j.injury.2015.08.037](https://doi.org/10.1016/j.injury.2015.08.037), indexed in Pubmed: [26384660](https://pubmed.ncbi.nlm.nih.gov/26384660/).
- Odetola FO, Gebremariam A. Paediatric trauma in the USA: patterns of emergency department visits and associated hospital resource use. *Int J Inj Contr Saf Promot*. 2015; 22(3): 260–266, doi: [10.1080/17457300.2014.925937](https://doi.org/10.1080/17457300.2014.925937), indexed in Pubmed: [24941303](https://pubmed.ncbi.nlm.nih.gov/24941303/).
- Agostinis-Sobrinho C, Gómez-Martínez S, Nova E, et al. Lifestyle patterns and endocrine, metabolic, and immunological biomarkers in European adolescents: The HELENA study. *Pediatr Diabetes*. 2019; 20(1): 23–31, doi: [10.1111/pedi.12802](https://doi.org/10.1111/pedi.12802), indexed in Pubmed: [30471163](https://pubmed.ncbi.nlm.nih.gov/30471163/).
- Issin A, Kockara N, Oner A, et al. Epidemiologic Properties of Pediatric Fractures in a Metropolitan Area of Turkey. *Medicine (Baltimore)*. 2015; 94(43): e1877, doi: [10.1097/MD.0000000000001877](https://doi.org/10.1097/MD.0000000000001877), indexed in Pubmed: [26512602](https://pubmed.ncbi.nlm.nih.gov/26512602/).
- Huleatt JB, Nissen CW, Milewski MD. Pediatric Sports Medicine Injuries: Common Problems and Solutions. *Clin Sports Med*. 2018; 37(2): 351–362, doi: [10.1016/j.csm.2017.12.012](https://doi.org/10.1016/j.csm.2017.12.012), indexed in Pubmed: [29525032](https://pubmed.ncbi.nlm.nih.gov/29525032/).
- Rubin G, Peleg K, Givon A, et al. Israel Trauma Group. Upper extremity fractures among hospitalized pediatric road traffic accident victims. *Am J Emerg Med*. 2015; 33(5): 667–670, doi: [10.1016/j.ajem.2015.02.017](https://doi.org/10.1016/j.ajem.2015.02.017), indexed in Pubmed: [25726065](https://pubmed.ncbi.nlm.nih.gov/25726065/).