

Hantavirus Infections in Turkey

Türkiye’de Hantavirüs Enfeksiyonları

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SUMMARY

Hantaviruses are a group of rodent-borne enveloped RNA viruses belonging to the genus Hantavirus, family Bunyaviridae. Hantaviruses cause two type of disease in people: hemorrhagic fever with renal syndrome (HFRS) and Hantavirus cardiopulmonary syndrome (HCPS). Type and severity of the disease are closely related with virus type: Hantavirus species in America cause HCPS while the species in Europe and Asia cause HFRS. Hantaviruses are carried by some species of rodents and insectivores. Turkey has a great biological diversity with 66 species of rodents and 18 species of insectivores. Among the rodent species and insectivore species in the world that are known to carry Hantaviruses, Myodes glareolus, Microtus arvalis, Apodemus flavicollis, Apodemus agrarius, Rattus norvegicus and Sorex araneus are also present in Turkey. Depending on the current rodent and insectivore species in the country, presence of the following Hantavirus species; Puumala, Tula, Hantaan, Seoul Dobrova, Saaremaa and Seewis may be speculatively anticipated in Turkey. However, to date, only one rodent species in Turkey (Microtus vole) has been shown to be seropositive for Hantavirus (type Puumala) in a rodent study. Hantavirus infections in humans have been reported in a wide geographic area including some of the neighbors of Turkey in the world. However, presence of IgG type antibodies against Hantavirus in serum samples of some individuals in Turkey has been detected in two studies performed in 1997 and 2004; acute Hantavirus infection and Hantavirus outbreak in humans have been first reported in Turkey in February 2009. That Hantavirus outbreak emerged in two provinces (Zonguldak and Bartın) which located at north-western part of the county. In this review, the studies on Hantaviruses in humans and in rodent populations in Turkey are summarized.

Key Words: Hantavirus, Kidney failure, Acute, Rodentia, Disease outbreaks

ÖZET

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Hantavirüsler Bunyaviridea ailesinde Hantavirus genusunda yer alan, kemirici kaynaklı bir grup zarflı RNA virüsleridir. Hantavirüsler insanlarda “böbrek yetmezliği ile seyreden kanamalı ateş” ve “Hantavirüs kalp-akciğer sendromu” olmak üzere iki tür hastalık tablosuna yol açar. Hastalığın tipi ve şiddeti Hantavirüs tipi ile yakından ilişkilidir: Amerika Birleşik Devletleri’nde bulunan Hantavirüs tipleri

"kalp-akciğer sendromuna" yol açarken Avrupa ve Asya'da bulunan Hantavirüs tipleri, "böbrek yetmezliği ile seyreden kanamalı ateşe" neden olur. Hantavirüsler bazı kemirici (rodent) ve böcekçil (insectivore) türleri tarafından taşınır. Ülkemiz 66 kemirici ve 16 böcekçil türü ile büyük bir biyolojik çeşitliliğe sahiptir. Dünyada Hantavirüsleri taşıdığı bilinen kemirici ve böcekçil türlerinden; *Myodes glareolus*, *Microtus arvalis*, *Apodemus flavicollis*, *Apodemus agrarius*, *Rattus norvegicus* ve *Sorex araneus* aynı zamanda ülkemizde de mevcuttur. Ülkemizde var olan kemirici ve böcekçil türleri temel alınarak Hantavirüs türlerinden; Puumala, Tula, Hantaan, Seoul Dobrova, Saaremaa ve Seewis'in Türkiye'de bulunabileceği spekülasyon olarak öngörülebilir. Buna rağmen günümüze kadar yurdumuzda sadece bir kemirici türünün (*Microtus vole*) Hantavirüs (Puumala türü) için seropozitif olduğu bir rodent çalışmasında gösterilmiştir. İnsanlarda Hantavirüs enfeksiyonu Türkiye'nin bazı komşularını da içeren dünya üzerindeki geniş bir coğrafik alanda bildirilmektedir. Türkiye'de bazı insanların serumlarında Hantavirüse karşı oluşan IgG tipi antikorların varlığı 1997 ve 2004 yıllarında yapılan iki çalışmada saptanarak birlikte, ülkemizde akut Hantavirüs enfeksiyonu ve Hantavirüs salgını ilk defa 2009 yılı Şubat ayında bildirilmiştir. Bu salgın ülkemizin kuzey batısında yer alan Zonguldak ve Bartın illerinde ortaya çıkmıştır. Bu derlemede Türkiye'deki insanlarda ve kemirici popülasyonlarında yapılan Hantavirüs çalışmaları özetlenmiştir.

Anahtar Kelimeler: Hantavirüs, Böbrek yetmezliği, Akut, Kemirici, Salgın hastalıklar

Hantaviruses are a group of rodent-borne enveloped RNA viruses belonging to the genus Hantavirus, family Bunyaviridae^[1]. Hantaviruses are carried by some species of rodents and insectivores. Each Hantavirus type is carried by a specific rodent species^[2] (Table 1). Hantaviruses cause persistent and generally asymptomatic infections in rodents and insectivores^[3]. These infected natural hosts can excrete the virus by their urine, feces, or saliva throughout their life^[4]. Humans are usually infected accidentally via inhaling virus-contaminated aerosol or ingesting virus-contaminated food or water, or direct inoculation of the virus into the body through erosions of the skin or through mucous membranes of the eye, nose or mouth during occupational activities. Therefore, individuals with potential risk for contact with Hantavirus-carrying rodents or their excreta (i.e. foresters, hunters, farmers) are at greater risk for Hantavirus infections.

Hantaviruses cause two types of disease in humans: hemorrhagic fever with renal syndrome (HFRS) and Hantavirus cardiopulmonary syndrome (HCPS). Type and severity of the disease are closely related with virus type: Hantavirus species in America cause HCPS while the species in Europe and Asia cause HFRS. Human to human transmission of Hantaviruses has not been reported to date, except for the Andes virus which is present in South America^[5].

Commonly used serodiagnostic tests for Hantavirus infections include indirect immunofluorescence assay (IFA), enzyme immune assay (EIA) and immunoblot assay. Antibodies against Hantavirus generally occur at the beginning of the disease; however, in 2-

4% of the patients infected with type Puumala, the seroconversion may be negative within the first 5 days after onset of the disease. However, while serologic tests are commonly used for diagnosis of Hantavirus infections, molecular diagnosis of the disease with polymerase chain reaction (PCR) has many advantages in certain situations:

1. Hantaviruses can be detected in a variety of clinical samples (i.e. serum, peripheral blood mononuclear cells, blood clots, urine, saliva, tissue biopsy and even in paraffin blocks).
2. Level of viral load in patient serum can be detected since outcome of the disease was found to be related with high level of viremia.
3. PCR can detect Hantavirus infection in the early stage of the disease, while Hantavirus antibodies in serum are not yet detectable.
4. Virus type can be identified with certainty since serologic cross-reactions may be seen among Hantavirus types. The gold standard for serotyping of the virus is "neutralization test", which can be performed only in reference centers^[2,3].

This review summarizes Hantavirus studies in human and rodent populations in Turkey.

STUDIES on HUMAN HANTAVIRUS INFECTIONS IN TURKEY

A literature search in English and Turkish regarding Hantavirus infections in Turkey revealed only a few studies on this topic (Table 2).

The first report about Hantavirus infection in Turkish, which included three cases diagnosed at SHA-

Table 1. The table shows the list of Hantaviruses and their carrier hosts (rodent species and insectivore species). Among the hosts, those present in Turkey or in the Zonguldak-Bartın region are indicated in the table*

Virus	Abbreviation	Host (rodent or insectivore)	Disease/area	Presence of the hosts in Zonguldak Bartın region ^[12]	Presence of the hosts in Turkey ^[13]
• Family Cricetidae, subfamily Arvicolinae					
Puumala	PUUV	<i>Myodes glareolus</i>	NE, Europe	+	+
Tula	TULV	<i>Microtus arvalis</i>	HFRS, Europe	-	+
Topografov	TOPV	<i>Lemmus sibiricus</i>	Asia	-	-
Khabarovsk	KHAV	<i>Microtus fortis</i>	Asia	-	-
Prospect Hill	PHV	<i>Microtus pennsylvanicus</i>	North America	-	-
Isla Vista	ISLAV	<i>Microtus californicus</i>	North America	-	-
Bloodland Lake	BLLV	<i>Microtus ochrogaster</i>	North America	-	-
Vladivostok	VLAV	<i>Microtus fortis</i>	Asia	-	-
Muju	MUJV	<i>Myodes regulus</i>	Asia	-	-
Hokkaido	HOKV	<i>Myodes rufocanus</i>	Asia	-	-
Fusong		<i>Myodes rufocanus</i>	Asia	-	-
• Family Cricetidae, subfamily Neotominae					
Sin Nombre	SNV	<i>Peromyscus maniculatus</i>	HCPS, North America	-	-
New York	NYW	<i>Peromyscus leucops</i>	HCPS, North America	-	-
El Moro Canyon	ELMCV	<i>Reithrodontomys megalotis</i>	North America	-	-
Rio Segundo	RIOSV	<i>Reithrodontomys mexicanus</i>	South America	-	-
Limestone Canyon	LSCV	<i>Reithrodontomys megalotis</i>	North America	-	-
• Family Cricetidae, subfamily Sigmodontinae					
Andes	ANDV	<i>Oligoryzomys longicaudatus</i>	HCPS, South America	-	-
Bayou	BAYV	<i>Orizomys palustris</i>	HCPS, North America	-	-
Black Creek Canal	BCCV	<i>Sigmodon hispidus</i>	HCPS, North America	-	-
Cano Delgado	CADV	<i>Sigmodon alstoni</i>	South America	-	-
Laguna Negra	LANV	<i>Calomys laucha</i>	HCPS, South America	-	-
Muleschoe	MULV	<i>Sigmodon hispidus</i>	North America	-	-
Rio Mamorae	RIOMV	<i>Oligoryzomys microtis</i>	South America	-	-
Blue River	BRV	<i>Peromyscus leucopus</i>	North America	-	-
Monongahela	MGLV	<i>Peromyscus maniculatus</i>	HCPS, North America	-	-
Bermejo	BMJV	<i>Oligoryzomys chacoensis</i>	HCPS, South America	-	-
Lechiguanas	LECV	<i>Oligoryzomys flavescens</i>	HCPS, South America	-	-
Maciel	MCLV	<i>Bolomys obscurus</i>	South America	-	-
Oran	ORNV	<i>Oligoryzomys longicaudatus</i>	HCPS, South America	-	-
Pergamino	PRGV	<i>Akodon azarae</i>	South America	-	-
Cochlo		<i>Oligoryzomys fulvescens</i>	HCPS, North and South America	-	-
Calabazo		<i>Zygodontomys brevicauda</i>	HCPS, South America	-	-
Araraquara		<i>Bolomys lasiurus</i>	HCPS, South America	-	-

Table 1. The table shows the list of Hantaviruses and their carrier hosts (rodent species and insectivore species). Among the hosts, those present in Turkey or in the Zonguldak-Bartın region are indicated in the table* (continued)

Virus	Abbreviation	Host (rodent or insectivore)	Disease/area	Presence of the hosts in Zonguldak Bartın region ^[12]	Presence of the hosts in Turkey ^[13]
• Family Muridae, subfamily Murinae					
Hantaan	HTNV	<i>Apodemus agrarius</i>	Asia HFRS	-	+
Seoul	SEOV	<i>Rattus norvegicus</i>	HFRS, global	+	+
Dobrava	DOBV	<i>Apodemus flavicollis</i>	HFRS, Europe	+	+
Thailand	THAI	<i>Bandicota indica</i>	Asia	-	-
Amur	AMRV	<i>Apodemus peninsulae</i>	HFRS, Asia	-	-
Soochong	SOOV	<i>Apodemus peninsulae</i>	Asia	-	-
Da Bie Shan	DBSV	<i>Niniventer confucianus</i>	Asia	-	-
Saaremaa	SAAV	<i>Apodemus agrarius</i>	HFRS, Europe	-	+
Sangassou	SANGV	<i>Hylomyscus simus</i>	Africa	-	-
• Insectivore (nonrodent)					
Thottapalayam	TPMV	<i>Suncus murinus</i>	Asia	-	-
Seewis	SEEV	<i>Sorex araneus</i>	Europe	+	+
Tanganya	TGNV	<i>Crocidura theresae</i>	Africa	-	-

* The table is adapted from Expert Rev Anti Infect Ther 2009;7(2):205-17 with permission of Expert Reviews Ltd.^[2]
HFRS: Hemorrhagic fever with renal syndrome, HCPS: Hantavirus cardiopulmonary syndrome.

PE Medical Centre in Belgium, was published in "Deniz Tıp Bülteni" in 1990 by Doganci et al.^[6]. The cases were not from Turkey but were NATO personnel from the United States, Canada and England working in Belgium, and contact with the causative agent did not occur in Turkey.

In Turkey, the first Hantavirus study in humans was conducted in 1993 by Haznedaroglu et al. at Gulhane Military Medical Academy, Ankara, in collaboration with Seoul University Hantavirus Collaborating Centre, Korea^[7]. In that study, serum samples of 106 Turkish military personnel, who were considered as having high risk for possible contact with Hantavirus due to occupational duties in nature, were tested for antibodies against Hantavirus using "high density particle agglutination method" (Green Cross Hantadia High Density Particular Assay), and none of the samples was positive for Hantavirus. Of those 106 military personnel, 24 served in Korea during the Korean War (1951-1953), where the disease was endemic. The authors stated that the number of sub-

jects was limited for drawing a general comment; however, the results showed that the soldiers had no previous contact with Hantaviruses and that Turkish soldiers might be a sensitive population for Hantavirus infections.

In a retrospective study, performed by Kavukcu et al. at Dokuz Eylul University Hospital in 1997, IgG antibodies against Hantavirus type 76-118 were detected by IFA method in serum samples of 231 pediatric and adult patients^[8]. In their study, serum samples were obtained from 82 patients with acute or chronic renal failure and from 149 patients who were hospitalized for any reason other than renal or infectious disorders. The samples were tested at the Microbiology Laboratory of Aristotelian University Medical Faculty, Thessaloniki, Greece (WHO Collaborating Center for Reference and Research on Arboviruses and Hemorrhagic Fever Virus). Ten (4.3%) of the patients were found to have antibodies against Hantavirus at variable titers ranging between 1/32 and 1/512. Seropositivity rate was 7.3% (6/82) in

Table 2. The summary of the reported Hantavirus studies in human and rodent populations performed in Turkey

Author name, date of study*	Test method and detected immunoglobulin type	Detected Hantavirus type	Number of subjects	Results
• Human studies				
Haznedaroglu, 1993 ^[7]	High density particle agglutination	type Hantaan type Seoul	106	All negative
Kavukcu, 1997 ^[8]	IFA/IgG	type Hantaan	231	10 (4.3%) positive
Aksaray, 2006 ^[9]	IFA/IgG and IgM	type Hantaan type Puumala type Seoul type Sin Nombre type Dobrova type Saaremaa	58	All negative (some weak-positive results were considered as cross-reaction)
Oktem, 2004 ^[10]	Micro-IFA and Western Blot/IgG	type Puumala type Dobrova	200	24 positive for type Dobrova (7 of 24 also positive by Western Blot)
Celebi, 2009 (unpublished)	IFA and EIA/IgG and IgM	type Hantaan type Puumala type Dobrova	Over 50 (continuing)	Positive over 20 (pending results)
• Rodent studies				
Laakkonen, 2004 ^[14]	IFA/IgG	type Puumala type Saaremaa	65 <i>Microtus voles</i> 264 <i>Apodemus</i> spp. 1 <i>Dryomys nitedula</i>	4 of the <i>Microtus voles</i> positive for type Puumala

* Superscript numbers denote the reference number.

the patients with nephropathy, whereas the rate was 2.6% (4/149) in the patients without nephropathy. When the subjects with acute nephropathy and chronic nephropathy were compared, seropositivity rates were 3.1% (1/32) and 10.0% (5/50), respectively, but the difference was not statistically significant. However, while they detected IgG type antibodies against Hantavirus in some of the patients, the seropositive patients did not describe any clinical picture compatible with HFRS in their interviews. In addition, clinical and histopathological findings of the seropositive patients with nephropathy were not related with HFRS. Thus, the authors considered those serological findings as abortive infections caused by Hantavirus rather than Hantavirus-related nephropathies.

Crimean-Congo hemorrhagic fever (CCHF) is a major public health problem in Turkey, and the CCHF virus and Hantaviruses are members of the sa-

me family Bunyaviridae. Aksaray et al. performed a study to investigate whether Hantavirus might be a causative agent in the patients suspected for CCHF^[9]. They detected serum samples of the 58 CCHF-suspected patients who admitted to their hospital between April-September 2006 for IgM and IgG antibodies against Hantavirus type Hantaan, type Puumala, type Seoul, type Sin Nombre, type Dobrova, and type Saaremaa by IFA (Hantavirus Mosaic 1, Euroimmun, Germany). They found that 6 of the 58 patients were positive for Hantavirus; however, all those positive serum samples gave a low level of fluorescence. Furthermore, all of the six cases were serologically confirmed to be infected with CCHF virus. Thus, the authors considered the presence of low-level antibodies against Hantavirus in the serum samples of those patients with CCHF to be cross-reactions due to the antigenic similarities in the Bunyaviridae family.

In another study performed by Oktem in 2004, though details of the study are not reported in the text, serum samples of 200 patients (from the Aegean region of Turkey) with acute or chronic renal failure were investigated for IgG type antibodies against Hantavirus type Dobrova and type Puumala^[10]. Twenty-four were positive for type Dobrova and among those 24 patients, 7 were also confirmed with Western Blot test.

THE FIRST HANTAVIRUS OUTBREAK in TURKEY

The first human Hantavirus infection, with compatible symptoms, signs and serological test results, and the first human Hantavirus outbreak in Turkey were detected in February 2009 by Celebi et al.^[11]. On February 20, 2009, a 45-years-old man was admitted to Zonguldak Karaelmas University Hospital with the complaints of fever, diarrhea, and abdominal pain. Although intensive supportive therapy and medications were provided, acute renal failure, acute respiratory failure and thrombocytopenia emerged and he showed a rapid and fatal clinical course due to an "unknown" disease. Clinical and laboratory findings of the patient were uncommon for the physicians in the hospital. A rapid search for similar cases in the

hospital medical-database revealed two other patients who admitted to the hospital in the same month and died due to a disease with unknown etiology.

The common clinical and laboratory findings between those three patients were fever, thrombocytopenia and acute renal failure that emerged as an acute disease. Two of the patients were from the Zonguldak province and the other was from the Bartın province. A Hantavirus outbreak was suspected and a case definition was developed according to the current clinical and epidemiological findings of those patients (Table 3).

The medical doctors in the two provinces were asked to report the patients who exhibited symptoms and clinical signs compatible with the case definition to the Infectious Diseases Department of Zonguldak Karaelmas University Hospital on February 23 and 24, 2009. The fourth Hantavirus suspected case was detected on February 24 and the suspicion of a Hantavirus outbreak raised concern of a possible Hantavirus outbreak. The local and central health authorities were immediately informed. In an effort to initiate a scientific collaboration, the members of national societies of microbiology and infectious diseases were also informed about the cases and the possible diagnosis via e-mail groups.

Table 3. The case definition developed to explore Hantavirus-suspected patients at the beginning of the Hantavirus outbreak in the Zonguldak-Bartın region of Turkey in February 2009.

Case definition for human Hantavirus infection

Risk area for Hantavirus infection:

Currently, the risk regions are the provinces of Zonguldak and Bartın. However, the risk region may widen if new cases are detected from other provinces.

Suspected case:

A case who has lived or been present in the risk area within the previous two months, who has no previously known hematologic or renal disorder and who presents the following clinical findings as an acute illness:

1. Fever
2. Thrombocytopenia
3. Acute renal failure or abnormal test results of renal function (elevation in BUN or creatinine levels in sera)

In addition to the findings listed above, diarrhea, abdominal pain, nausea, vomiting, myalgia, loss of consciousness, and hemorrhage in skin or mucosa may be seen.

Serologically confirmed case:

A suspected case is considered serologically confirmed if Hantavirus IgM is positive in one serum sample or if there is a significant increase in IgG titer in subsequent serum samples obtained in the acute and convalescence period of the disease.

Hantavirus IgM and IgG were found to be positive in serum samples of the last two cases in the Microbiology Laboratory of Dokuz Eylül University Hospital, Izmir and at Refik Saydam National Public Health Agency, Ankara^[11]. Hantavirus infection is not a well-known disease in Turkey. It should be stressed that this Hantavirus outbreak was exposed as a result of the successful usage of basic steps of scientific method (suspicion-observation-composing hypothesis-collecting data-analyzing results) rather than being based on general knowledge or experiences of the authors about Hantavirus infections.

During the Zonguldak-Bartın Hantavirus outbreak, more than 50 suspected cases with acute Hantavirus infection were serologically tested and at least 20 of them were found to be compatible with acute Hantavirus infection. Most of the seropositive patients were male and only one death occurred among those seropositive patients. However, while serological tests confirmed the presence of acute Hantavirus infection in our patients, Hantaviruses could not be detected by PCR in any of the clinical samples of those patients to date (unpublished data).

RODENT POPULATION in TURKEY

Turkey is a country at the crossroads of the Asian, European and African continents, and it has a great biological diversity with 66 species of rodents and 18 species of insectivores^[12,13]. Among the rodent species and insectivore species in the world that are known to carry Hantaviruses, all types found in Europe (*Myodes glareolus*, *Microtus arvalis*, *Apodemus flavicollis*, *Apodemus agrarius*, *Rattus norvegicus* and *Sorex araneus*) are also present in Turkey, while none of the types from the Americas (except *Rattus norvegicus*) are found in Turkey (Table 1). Depending on the current rodent and insectivore species in the country, presence of the following Hantavirus species (PUUV, TULV, HTNV, SEOV, DOBV, SAAV and SEEV) may be speculatively anticipated in Turkey.

STUDIES on HANTAVIRUS in the RODENT POPULATION in TURKEY

There has been only one reported study that investigated the presence of Hantavirus in the rodent population trapped in Turkey^[14]. In that study, performed in April 2004, Finnish and Turkish investigators trapped a total of 330 rodents from three pro-

vinces of Turkey (Rize and Trabzon in the northeastern region and Izmir in the western region). Blood samples of the trapped rodents were detected by IFA in Hartman Institute, Helsinki, Finland. Antibodies against Hantavirus type Puumala were positive in 4 of the 65 *Microtus* voles; however, Hantavirus detection by PCR was negative in those seropositive rodents. Antibodies against Hantavirus type Saaremaa were negative in 264 *Apodemus* spp. mice. The only *Dryomys nitedula* type rodent was negative for both Hantavirus types Puumala and Saaremaa. The authors pointed out the need for additional studies since one of the antibody-positive rodents was trapped in the area of the Izmir province, from which seropositive human cases were also reported.

In June 2009, some Turkish investigators (including the second author of this review) conducted a study to detect Hantavirus in rodent species trapped in the outbreak area (Zonguldak-Bartın) and in some other geographic regions of Turkey. The results of those studies have not been reported yet.

Bartın and Zonguldak areas are adjacent and have similar vegetation. Most forests were dominated by Oriental Beech (*Fagus orientalis*). Other tree species mixed with Oriental Beech were Nordmann Fir (*Abies nordmanniana*), Chestnut (*Castanea sativa*), Linden (*Tilia* spp.), and Oriental Hornbeam (*Carpinus orientalis*). The Oriental Beech has produced more seeds in some years, and this increase means more food for rodents. In personal communication with forest officers in Bartın, they stated that there was no increased seed production in Zonguldak and Bartın in 2008, the year preceding the outbreak. There have been no long-term and systematic records of population dynamics among the rodent population around Zonguldak-Bartın. However, trapping success was more than 20% during the Hantaviruses survey around Bartın and Zonguldak in June 2009. According to our experience in field studies for more than 15 years, our trapping success was about 4-8% in such habitat types. We thus evaluated this trapping success as if a population explosion was seen in 2009, made possible because of moderate and rainier winter conditions than in previous winters. However, to collect precise data, ongoing, continuous population dynamic studies should be performed in the coming years for obtaining cooperative quantitative data on population density.

LIMITATIONS of HANTAVIRUS STUDIES in TURKEY

Antibodies against some Hantavirus types were detected in some of the serum samples of the subjects in the studies performed before 2009; however, no symptoms or clinical signs compatible with Hantavirus infection were described in those patients. Acute Hantavirus infection with compatible symptoms, clinical signs and with supporting serologic test results was first described in Turkey in February 2009^[11]. Despite presence of seropositive samples for Hantaviruses in both human studies and in the rodent study, Hantaviruses could not be detected by PCR in any of the clinical samples or in rodent samples in Turkey, even in the samples obtained from the seropositive subjects. In addition, in human studies in the Aegean region, the subjects were seropositive for Hantavirus type Hantaan and type Dobrova but negative for type Puumala^[8,10]. In contrast to results of the human studies, in the rodent study, none of the 59 *Apodemus* spp. rodents (this species carries type Hantaan, type Dobrova and type Saarema) captured in the Aegean region was positive for Hantaviruses but one *Microtus* type rodent was positive for type Puumala.

In conclusion, Hantavirus infection is a reality in Turkey but little is known about the epidemiologic characteristics of the disease in humans and the virus dynamics in the rodent population in the country. Further investigations in both human and rodent populations are needed in Turkey to explore Hantavirus types in certain rodent species and to understand the linkage between the types in rodents versus those in patients with Hantavirus infection.

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