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THE RELATIONSHIP BETWEEN BATTLE INTENSITY AND DISEASE RATES AMONG MARINE CORPS INFANTRY UNITS

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SUMMARY

Problem

Medical resource planning requires projections of disease and non-battle injury (DNBI) rates as well as anticipated casualty incidence for various operational scenarios. Additionally, any fluctuations in DNBI rates with battle intensity level have important manpower and medical policy planning implications.

Objective

The present investigation seeks to determine the DNBI rates among Marine Corps infantry battalions participating in two different operational scenarios, the Okinawa assault and the Korean War.

Approach

Casualty and DNBI rates were computed using data from muster rolls and unit diaries of Marine Corps battalions involved in the Okinawa operation and the Korean War. Daily rates and weekly incidence per 1000 strength per day were calculated for both operations.

Results

The rate of DNBI varied with battle intensity level. In Okinawa, the casualty and DNBI rates, respectively for various battle intensities were: low -- 1.18 and 2.15; moderate -- 8.37 and 4.24; and high intensity -- 27.56 and 10.27. Correlational analyses for both Korea and Okinawa indicated that DNBI incidence was significantly related to WIA rate, KIA rate, and the preceding week's WIA rate.

Conclusions

Medical resource planning must factor anticipated casualty levels into its computations of DNBI incidence. Casualty incidence and the severity of the wounds will both impact the concurrent DNBI rates and those of the time period immediately following.

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Accurate projections of casualty rates as well as forecasts of the incidence of disease and non-battle injuries (DNBI) are critical components to the planning of operational missions. These estimates allow medical planners to pre-position the required medical resources and enable manpower logisticians to gauge theater personnel replacement needs. Such projections are used as input to the following models: Joint Operations Planning and Execution System's (JOPES) Medical Planning and Execution System[1], the Navy's Wartime Manpower Planning System (WARMAPS)[2], and the Deployable Medical Systems (DEPMEDS) initiative[3].

While the treatment of battle wounds is often very labor- and resource-intensive, records indicate that admissions due to disease and non-battle trauma far outnumber admissions for combat injuries[4,5,6]. An examination of the inpatient records for U.S. Marines in Vietnam yielded a DNBI rate twice that of the wounded-in-action (WIA) admission rate[7,8]. One partial explanation for a high frequency of wartime DNBI is that personnel, who under peacetime conditions would normally be treated on an outpatient basis and/or returned to their quarters, during wartime must be evacuated to increase the availability of bed space and theater health care personnel for trauma surgeries[9]. Evacuations of personnel from the forward most positions require that they be admitted to a treatment facility at an echelon to the rear.

Wartime DNBI incidence consists of three major components: diseases, non-battle induced injuries, and battlefield stress casualties. Combat stress is not a new phenomenon and there are numerous documented accounts of soldiers being incapacitated by the psychological demands of war[10,11,12,13]. There is also considerable evidence that stress can impair the immmunological system's ability to resist disease[14,15] which could also contribute to elevated rates of disease among troops engaged in hostile operations.

The objective of the present investigation is to examine the relationship between battle intensity and DNBI rates among various land-based Marine Corps units. Because these rates will include battle fatigue/stress cases, as well as diseases which may indirectly result from stress-induced immunosuppression, it is anticipated that DNBI rates will increase with the level of combat intensity. Peacetime rates of units in the same geographical region will also be examined for comparative purposes.

METHOD

An accurate assessment of combat's influence on DNBI incidence requires that rates be examined for extended conflicts so that the effects of combat stress have sufficient time to fully manifest themselves. The conflicts examined should also represent military operations in which the overall intensity levels were moderate to high; though there are periods of heightened and lessened activity in all combat operations, the range of intensity levels would be more distinct in moderate- and high-intensity conflicts than in low level operations. Because of the requirements for data from extended operations of at least moderate intensity, data from two sources, the Korean Conflict and the assault on Okinawa during World War II, were considered to be the most appropriate for this study.

Casualty and DNBI occurrences were extracted from Muster Rolls housed at the National Archives in Washington, D.C. and from Unit Diaries kept at the Marine Corps Historical Center, also in Washington. The WIA and DNBI entries generally represent cases that were treated at second and third echelon treatment facilities (Medical Battalion, Field Hospital, and Casualty Treatment and Receiving Ships). However, some of the wounded and sick were recorded as being treated at the Battalion Aid Station level, especially during the Okinawa operation.

Casualty and DNBI rates for wartime and peacetime data sets were computed per 1000 strength per day. Confidence limits were calculated to determine if disease rates differed significantly by combat intensity level. The Okinawa and Korea rates were computed over both daily and weekly time periods. Pearson product moment correlation was used to determine the degree of relationship between weekly casualty rates and DNBI rates of the individual Marine battalions and companies. Though not denoting an absolute cause-and-effect relationship, significant correlations imply that as one rate changes so does the other.

Okinawa Data

The assault on Okinawa was a three-month operation lasting from April through June of 1945. Marines involved in the assault included the 1ST Division, the 6TH Division, and, in the closing stage, the Eighth Marines from the 2ND Division. The monthly muster rolls included information on the number of personnel in each unit (battalion or company), and the individuals who were wounded, killed, and sick. Data were extracted from 22 battalion monthly muster rolls and 36 company muster rolls from the 1ST and 6TH divisions. Though muster roll data were not available for all units throughout the operation, these 58 muster rolls account for 471,936 mandays in April; 244,074 mandays in May; and 153,976 mandays in June.

It is generally conceded by military historians that the Okinawan operation ran the full gamut of combat intensity levels. Historical accounts of the battle of Okinawa[16,17] were examined to determine intensity levels during different phases of the operation. These accounts typically describe the combat activities, as well as the resistance met, of specific units over the course of the operation. The following definitions of intensity were applied to seven-day periods from April through June 1945: Low Intensity -- no other level of combat during the week than that characterized by historians as 'light'; Moderate Intensity -- there was at least one day characterized as 'heavy', or there was no more than one day in the seven day period characterized as 'intense' combined with one or more days of light combat; High Intensity -- there were at least two days in the week characterized as 'intense' with the rest being heavy. These definitions yielded 44 'unit by week' combinations of low intensity, 27 instances of moderate intensity, and 25 weeks in which specific units were engaged in high intensity combat. Intensity level was not ascertainable for 12 'unit by week' combinations.

Korea Data

Additionally, data were extracted from Unit Diaries of Marine Corps battalions deployed to Korea in 1951. The tempo of operations during the Korean War was generally more moderate than the overall higher intensity level seen in WWII. Nevertheless, a five month period of data was extracted for battalions of the 1ST Marine Division (February-June 1951) which saw a range of combat intensities. Data for this time period were available for five Headquarters & Service (H&S) Companies, four Weapons Companies, and 11 Rifle Companies that were elements of the 1ST and 5TH Regiments. The total mandays represented by these 20 companies was 625,209. The numbers of WIA, KIA, DNBI, and mandays for the Korea data set were aggregated on a daily as well as weekly basis. Historical accounts of the Korean Conflict were not detailed enough to provide week-to-week descriptions of intensity levels.

Peacetime Data

Data were also extracted for Marine units stationed in similar geographical regions immediately after or prior to hostilities so that peacetime illness rates could be computed, and contrasted with wartime rates. Medical data from 17 muster rolls of Marine Corps battalions of the 2ND and 5TH Divisions, deployed as occupying forces in Nagasaki, Sasebo, and Kyushu during October and November of 1945, were used to compute the peacetime rate; this data represented 432,965 mandays. Data from the muster rolls of the 1ST and 3RD Marines stationed in Tsingtao, China in 1948 were used to compute DNBI rates to be compared with Marines in the Korean Conflict. Only data for February through June were used in an effort to reflect the same climatic influences upon health experienced by the troops used in the Korea analyses. A total of 223,382 mandays were represented by these troops stationed in Tsingtao during these five months in 1948.

RESULTS

Okinawa

The overall WIA and KIA rates per 1000 men per day for the infantry units engaged in the Okinawa operation were 5.77 and 1.46, respectively. The rate of DNBI admissions requiring at least second echelon medical treatment over the three-month assault period was 4.21, while the DNBI rate among the Marine units occupying Japan after the cessation of hostilities was 0.73.

Comparisons of disease and non-battle injury rates by combat intensity indicated that DNBI incidence increased with level of combat. The Okinawa database yielded the following data points when Marine infantry unit rates were aggregated over seven-day periods: Low Intensity -- casualty rate of 1.18 per 1000/day, DNBI rate of 2.15; Moderate Intensity -- casualty rate of 8.37, DNBI rate of 4.24; High Intensity -- casualty rate of 27.56, DNBI rate of 10.27. Confidence limits indicated that the High intensity DNBI rate was significantly greater ($p < .001$) than both the Moderate and Low battle intensity DNBI rates, and that the Moderate combat level DNBI rate was also significantly higher ($p < .001$) than the Low intensity rate. A graph depicting the relationship between DNBI incidence and casualty rates during the Okinawa operation is presented in Figure 1.

Correlational analyses indicated highly significant ($p < .001$) associations between weekly DNBI rate and WIA rate among the individual battalions and companies ($r=.604$, $df=230$), DNBI rate and

KIA rate (r=.607, df=230), and DNBI and the previous week's WIA rate (r=.266, df=172). The relationship between DNBI rate and the previous week's KIA rate was also significant (r=.214; $p < .005$, df=172).

While examining rates over seven-day periods may be sensitive enough for determining needed medical resources, casualty rates tend to fluctuate on a daily, if not hourly, basis. Figure 2 illustrates the variations in the WIA and KIA rates across all 90 days of the Okinawa operation. This figure delineates the low levels of resistance in the first and last weeks of the operation with heightened opposition between Day 30 and Day 60. Figure 3 displays the pulses in DNBI incidence in conjunction with the casualty rates during the same time period; the highest DNBI rates were seen between days 40 and 65.

Korea

The overall WIA and KIA rates per 1000 strength per day for the Marine units deployed to Korea between February and June 1951 were 2.75 and 0.20, respectively. The DNBI rate for these units was 3.31. The casualty rate for Headquarter & Service Companies separately was 1.05, while the casualty rates for Weapons Companies and Rifle Companies were 2.04 and 3.99. The DNBI rates for H&S, Weapons, and Infantry units are juxtaposed with their casualty rates in Figure 4. The DNBI rate for Marines stationed in Tsingtao, China between February and June of 1948 was 2.24 per 1000 strength per day.

Though there were periods of intense combat within the Korean theater during the time period examined, these spans of intensified fighting were typically of short duration--often lasting less than a day or two. For this reason, it was inappropriate to assign intensity levels to seven-day periods. Figure 5 illustrates the sporadic intensity of this conflict with a graph of the WIA and KIA rates over the five month period of this study. Figure 6 displays the pulses in DNBI incidence in relation to the fluctuations in casualty rates.

Correlational analyses indicated highly significant ($p < .001$) associations between weekly DNBI rate and WIA rate of the individual companies ($r=.331$, $df=418$), DNBI rate and KIA rate ($r=.216$, $df=418$), and DNBI and the previous week's WIA rate ($r=.253$, $df=398$). Additionally, to determine if the severity of the wounds inflicted were related to DNBI incidence, the average number of days on sick list for WIA cases (until transfer or return to duty) were examined in conjunction with DNBI rate. There was a significant positive correlation between the mean number of days on the sick list among wounded personnel and that unit's weekly DNBI rate ($r=.150$, $p < .001$, $df=418$).

Lastly, length of time on sick list was examined for the DNBI cases to determine whether the admissions represented outpatient visits or were of a nature which would require substantial medical resources. There were 1,930 DNBI cases among the Marine units during the examined five-month period which required treatment at a second echelon facility or higher. One thousand four hundred and thirty five cases were returned to duty while the remainder were transferred out of the theater. Of the 1,435 cases which were returned to duty, only 6.7% were returned on the same day they sought treatment. Table 1 shows the distribution of days on sick list among DNBI cases who were returned to duty. The mean number of days on the sick list before return to duty was 9.52.

DISCUSSION

Examination of disease and non-battle injury rates in conjunction with levels of combat intensity indicated that there was a concomitant increase in DNBI rates with rises in battle intensity. This finding held up for Marine Corps operations in both World War II and Korea.

Among infantry units deployed for the assault on Okinawa, there was a clear relationship between weekly DNBI rates and battle intensity levels as reported in historical accounts. The relatively short length of the assault and capture of the island yielded extensive accounts detailing the amounts of Japanese resistance that various Marine battalions and companies met. Indeed, when examining the casualty rates associated with the intensity levels extracted from the historical accounts, there were parallel rises in both WIA and KIA with the amount of stated resistance. One problem, however, with using anecdotal information to determine intensity levels is that often the person describing the fighting is greatly influenced by the number of casualties sustained; that is, combat level was determined to be intense at least partly because numerous soldiers were wounded or killed. Circular definitions of battle intensity aside, there was a positive and significant association between casualty levels and DNBI incidence. These associations were further borne out by correlations between weekly DNBI and WIA rates, DNBI and KIA rates, and DNBI and the preceding week's casualty rates. Graphical presentation of the daily fluctuations in casualty and DNBI rates also illustrated that rises in casualty rates were either accompanied by or immediately followed by pulses in DNBI incidence.

While the historical accounts of Korea did not provide the necessary detail to independently assess intensity level, weekly casualty rates of the five-month period of the study indicated large variations in the numbers of WIA and KIA. As with the Okinawa data, significant correlations were evidenced between DNBI rate and WIA rate, DNBI rate and KIA rate, and DNBI rate and the preceding week's WIA rate. Likewise, graphical presentation of the daily DNBI and casualty rates depicted rises in DNBI incidence concurrent with or immediately following peaks in casualty incidence.

The data from the Marines deployed to Korea further indicated that the sick list admissions were of a nature which would require substantial medical resources to be committed. The length of time before a return to duty averaged almost ten days. In fact, while sixty-four percent of the wounded soldiers who eventually returned to their units were treated and returned on the first day, less than seven percent of the sick list admissions who were returned to their unit did so on the initial day of treatment. These statistics indicate that the illnesses, non-battle injuries, and fatigue cases which comprise the admissions to the treatment facility were serious enough to warrant extended stays.

The overall WIA rate (2.75 per 1000 per day) among the Marines in the Korea database is deceptively similar to their DNBI rate (3.31). However, when the proportion of DNBI to WIA is calculated for just those admissions which did not result in an immediate release upon treatment, the DNBI to WIA ratio was 1.90:1. This statistic is comparable to the 2 to 1 ratio seen for DNBI and WIA inpatient admissions among Marines in Vietnam[8].

The Okinawa and Korea records indicate that the overall DNBI rate of infantry battalions across extended engagements averaged 3.5 - 4.5 per 1000 men per day. These rates, however, will vary significantly with the type of unit, the current intensity of battle, and the intensity of battle in the preceding week. Further, the severity of the wounds sustained by a unit may also influence the rate of DNBI among that unit. That rate of casualties and wound severities may influence the number of sick list admissions suggests a psychological impact of combat stress which may never be fully quantified. Efforts are currently underway to develop a regression equation which will allow projection of DNBI rates from all of the known parameters.

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FIGURE 1. CASUALTY AND DNBI RATES OF MARINES OCCUPYING JAPAN AFTER THE WAR AND DURING THE OKINAWA ASSAULT

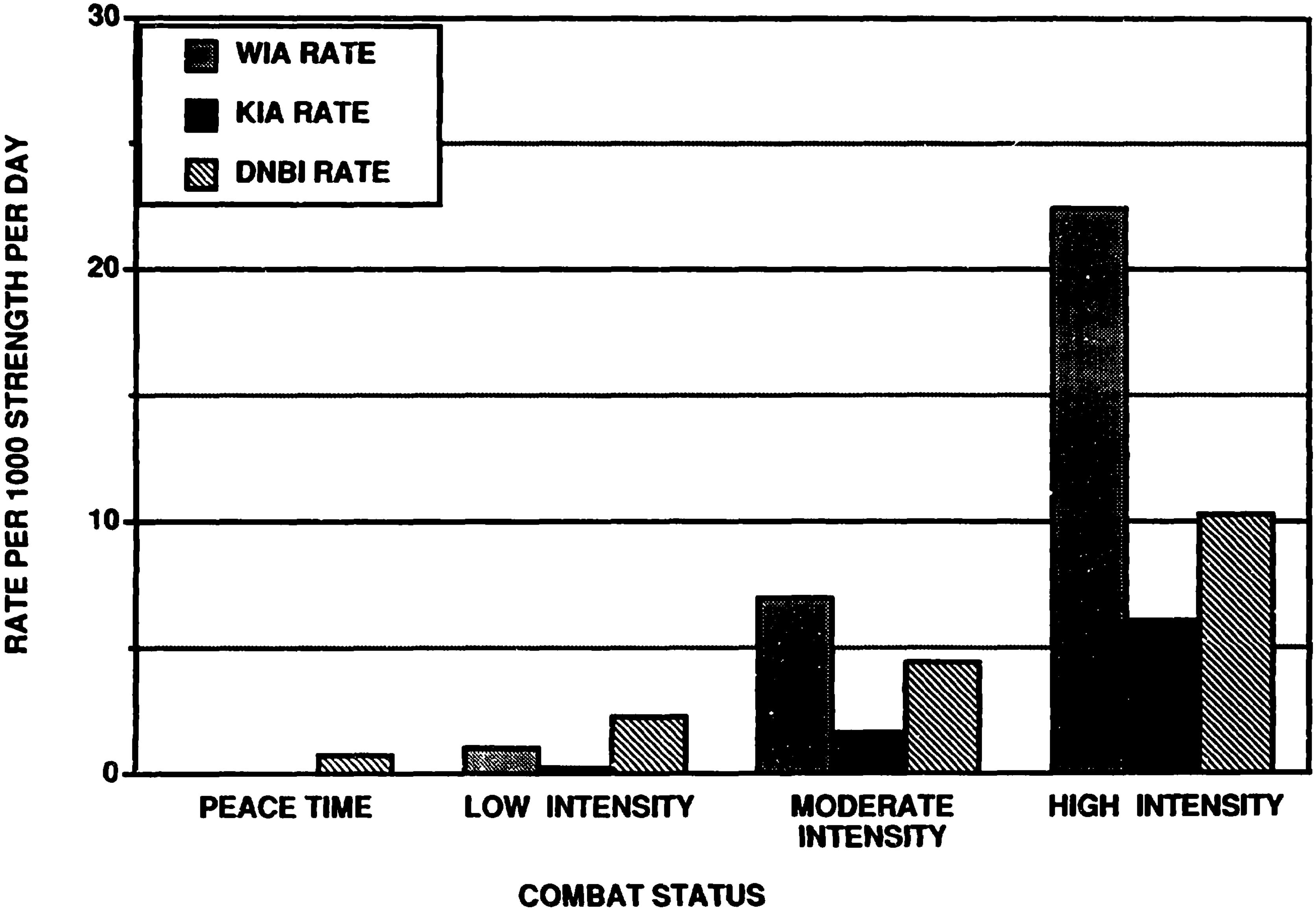

FIGURE 2. DAILY WIA AND KIA RATES AMONG U.S. MARINE INFANTRY UNITS DURING THE OKINAWA OPERATION

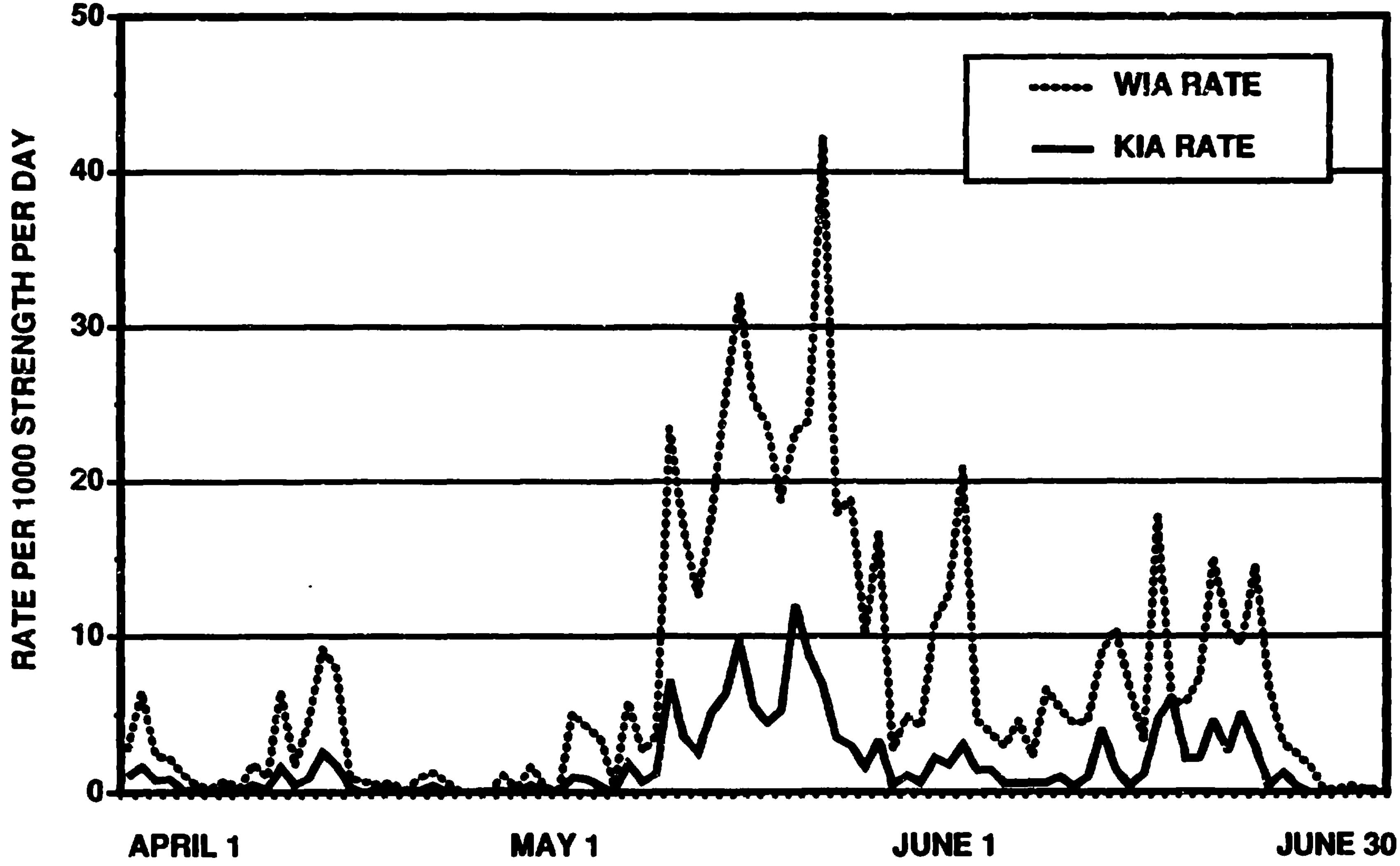

FIGURE 3. DAILY CASUALTY AND DNBI RATES AMONG U.S. MARINE INFANTRY UNITS DURING THE OKINAWA OPERATION

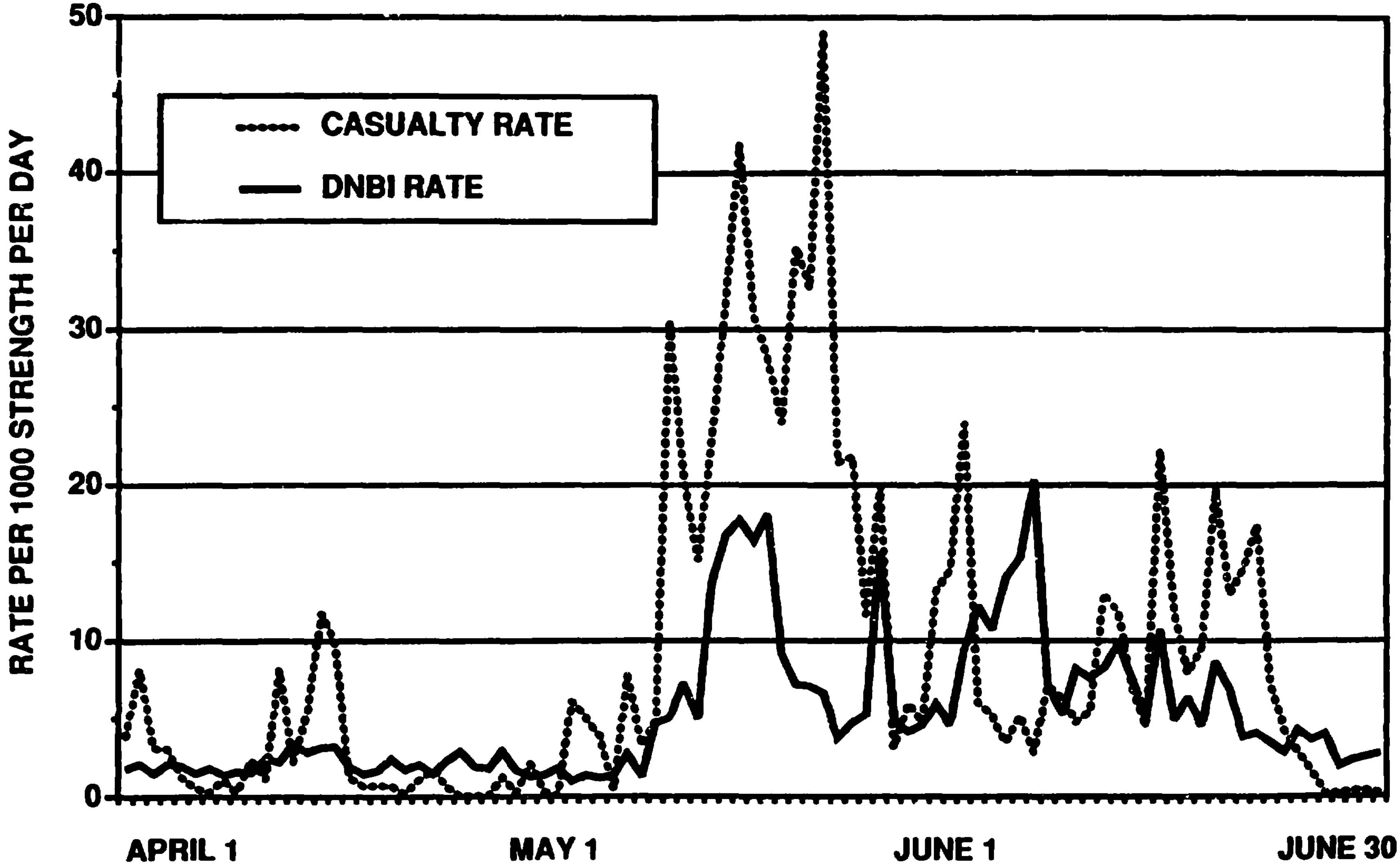

FIGURE 4. RATES OF CASUALTIES AND DNBI INCIDENCE AMONG MARINES BY TYPE OF COMPANY; KOREA, FEB - JUNE 1951

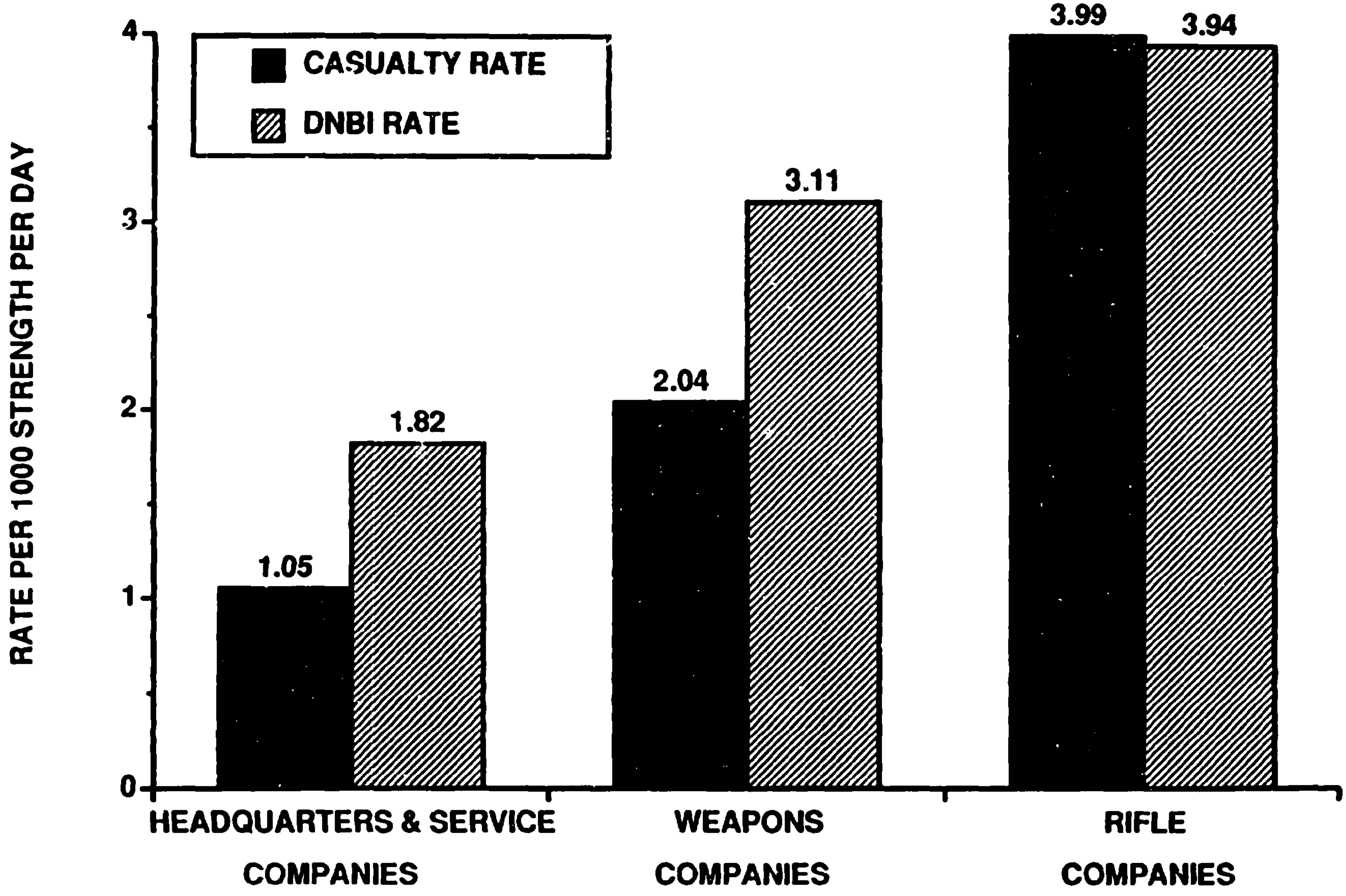

FIGURE 5. DAILY WIA AND KIA RATES AMONG MARINE INFANTRY BATTALIONS SERVING IN KOREA; FEB - JUNE 1951

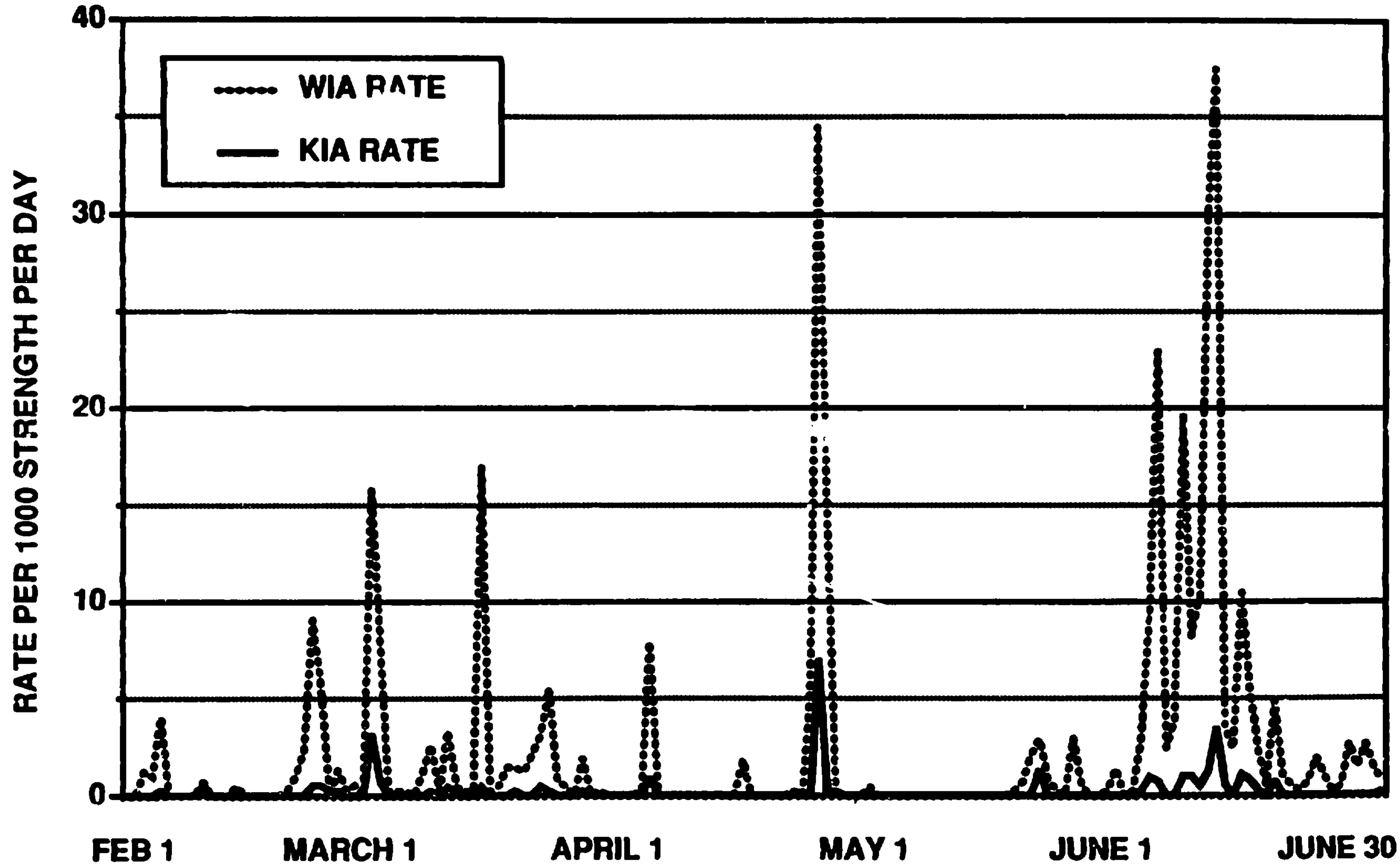

FIGURE 6. DAILY CASUALTY AND DNBI RATES AMONG MARINE INFANTRY BATTALIONS SERVING IN KOREA; FEB - JUNE 1951

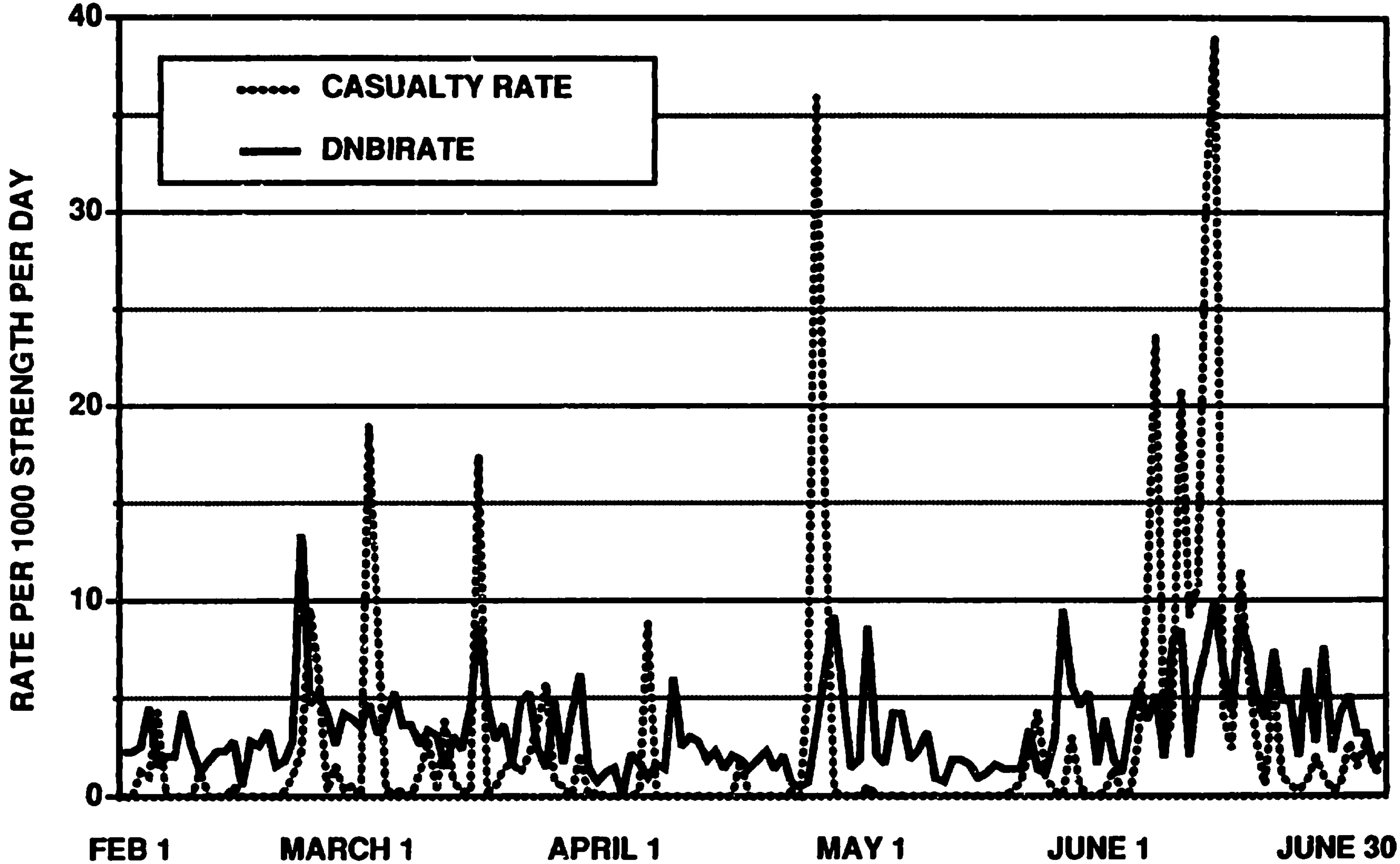

TABLE 1. NUMBER OF DAYS ON SICK LIST AMONG MARINE DNBI CASES THAT RETURNED TO DUTY; KOREA, FEB - JUNE 1951.

Number of Days on Sick List	Percent of Returned to Duty Sick Admissions
0	6.69
1	3.69
2	5.57
3	5.99
4	8.99
5	8.50
6	7.73
7	6.97
8	5.57
9	4.67
10	4.25
11	2.79
12	3.28
13	2.93
14	2.93
15	2.16
16 - 20	6.76
21 - 25	4.88
26 - 30	1.67
31 - 40	2.72
41 - 50	0.84
51+	0.42
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13. ABSTRACT *(Maximum 200 words)*

Disease and Non-Battle Injury (DNBI) rates were examined in conjunction with casualty rates across two Marine Corps operational scenarios, the assault on Okinawa and the Korean War. Both operations saw wide fluctuations in the daily and weekly Wounded-In-Action (WIA) and Killed-In-Action (KIA) rates. DNBI rates increased significantly with battle intensity among Marine infantry battalions involved in the Okinawa assault. The DNBI rates for low, moderate, and high intensities during the Okinawa operation were 2.15, 4.24, and 10.27 per 1000 men per day. Highly significant positive correlations ($p < .001$) were evidenced between DNBI rate and WIA rate, DNBI rate and KIA rate, and DNBI rate and the preceding week's WIA rate among infantry units in both Okinawa and Korea. A significant correlation was also evidenced between the severity of wounds sustained and DNBI rate.

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